SESAME (KENYA) PROJECT

PHASE II

Final Report for the

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE,

OTTAWA, CANADA

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DECLARATION

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INTRODUCTION

This is the third and final report of Sesame (K) Project II. The report highlights the findings of the sesame research conducted at Siaya in Nyanza Province, Kibwezi in Eastern Province and Mtwapa in Coast Province. The report starts with a summary of the findings that had been detailed in first two reports submitted to IDRC in 1994 and 1995.

This is followed by details of agronomic experiments, germplasm acquisition and varietal development activities undertaken between October 1994 and August 1996. The final report summarises efforts made by the project towards sesame research capacity building, recommendations and dissemination of the project results.

3. SUMMARY OF RESULTS OF YEARS I AND II

The results of years I and II of Sesame (K) Project II were detailed in our first two reports, i.e., reports submitted to the International Development Research Centre in 1994 and 1995. The conclusions of our results for the first two years are highlighted below.

In the first year crop-water relations studies were conducted in the greenhouse at Kabete and in the field at Kibwezi to screen the germplasm for resistance to drought conditions. At the same time the germplasm were screened for general agronomic acceptability, adaptability to the dryland conditions in Kibwezi and medium rainfall conditions in Siaya and Mtwapa. Experiments were also conducted to select cultivars resistant to *Cercospora* leaf spot. From these studies the following conclusions were made in the first year of the project.

(i) There was genetic variability among the sesame cultivars that could be utilised for improvement of the crop for dryland areas. The cultivars SPS SIK 70, SPS SIK 72, SPS SIK 95, SIK 004 and SPS SIK 5001 were observed to have the potential for drought resistance and would be useful for improving sesame for dryland adaptability.

(ii) There was significant correlation between root length density on one hand, stomatal conductance and relative water content on the other hand.

(iii) Significant correlation coefficient between traits studied in the glasshouse and in the field suggested that artificially induced water stress could serve in selecting drought resistant genotypes for production in dryland areas.

(iv) It was recommended that:

(a) Forty six genotypes be subjected to further screening at Kibwezi.

(b) Thirteen genotypes be subjected to preliminary yield trials at Siaya.

(c) Sixteen genotypes be subjected to preliminary yield trials at Mtwapa.

(v) Studies on *Cercospora* leaf spot indicated that *C. sesami* and *C. sesamicola* could successfully infect wild sesame. Hence wild sesame species can act as alternative hosts for this disease. On the other hand it was observed that *C. sesami* could not infect *Sesame latifolium.* It was concluded that this species had resistance to *C. sesami* which could be transferred to the cultivated sesame.

In the second year studies were conducted to investigate the response of sesame growth on varying levels of nitrogen applications. Varietal development studies were also conducted at Siaya and Mtwapa involving the screening of assembled germplasm. From these studies the following observation were made.

(i) Nitrogen did not show any effect on sesame growth. However, when sand was used as the growth medium there were indications of positive effect of nitrogen on plant height.

(ii) Of the cultivars subjected to preliminary trials at Siaya SPS SIK 93/008, SPS SIK 31, SPS SIK 25, SPS SIK 16, SPS SIK 6, SPS SIK Z 3, SIK 108 and SIK 019 had yields of at least 800 kg/ha during the long rains of April to August 1994.

(iii) Among the cultivars subjected to preliminary observations at Siaya SPS SIK Z 1, SPS SIK 045, SPS SIK 47, SPS SIK 93/2/004, SPS SIK 112 and SPS SIK 122 were identified as promising.

(iv) Preliminary trials at Mtwapa identified SIK 016, SIK 037, SPS SIK 118, SPS SIK 113 and SPS SIK 50/1 as promising.

4.1 AGRONOMIC EXPERIMENTS

4.1.1. Objective:

i) **Assess preliminary agronomic recommendations made during Phase I of the project and improve sesame agronomic practices.**

4.1.2. Introduction

Recent studies in Kenya have shown that sesame growth and yield do not respond to N and P fertilizers under field conditions (Ayiecho and Nyabundi, 1995; Odeny *et al.*, 1994). This appears to be an extensive phenomenon in Africa as similar lack of response has been reported in Ethiopia (Omran, 1985) and Sudan (Osman, 1985). Elsewhere, yields of sesame have been reported to increase with application of N and P as reported in India (Intnal, 1993; Puste and Maiti, 1987) and Venezuela (Pineda and Velasquez, 1986).

The lack of response to major nutrients such as N and P would be attributed to adequate amounts of the nutrients being already available in the soil or inability of the crop to take up and/or utilize the increasing amounts. In the work of Odeny *et al.* (1994), the soil N content was only 0.1 % and thus too low to meet the demands of most crop species. There is, however, the possibility that this crop had a capacity to mine this otherwise deficient soil N and thus meet its demands.

Mycorrhizae (root fungus) have been known to greatly affect nutrient availability and uptake by plants. Many plants depend on their mycorrhizal associations for adequate uptake of water and nutrients and survival in natural ecosystems

(Mason *et al.*, 1991). The role of mycorrhizae in enhancement of P uptake is well documented (Dubey, 1993). Harley and Smith (1975) showed that inflow into mycorrhizal roots was on average 3-4 times greater than into uninfected onion roots. While this may be explained in terms of continued growth and ramification of mycorrhizal mycelia into the soil thereby extending beyond the phosphate depletion zone around the roots, Mosse *et al.* (1973) suggested that mycorrhizal infection might alter the threshold concentration from which plants were able to absorb phosphates. In work by Cress *et al.* (1979) using cassava, it was found that affinity of the uptake sites for phosphate was much higher in the mycorrhizal roots. This work with cassava is found relevant to the sesame situation in that, even though the cassava has high phosphate requirement coupled with a very inefficient phosphate uptake system in the absence of mycorrhizal infection, it, like sesame , is still well known for its relatively high productivity in low fertility soils. The phosphate uptake capacity of cassava is markedly increased when the roots are infected with mycorrhizal fungi (Harley and Smith, 1983). Evidence implicating mycorrhizae in enhanced uptake of Nitrogen under low soil N conditions discussed by Harley and Smith, 1983.

In view of the foregoing literature this experiment was conducted to examine the relationship between sesame response to N and P on one hand and mycorrhizal infection on the other. Earlier results (Ayiecho and Nyabundi, 1995) showed that sesame height responded positively to increasing N and P in sterilized media but not in unsterilized field soil. This phase of study looked at biomass yield and actual mycorrhizal infection of sesame plants grown in various media.

In 1995/96 period, we continued with the studies in 1994/95 period and reported in the preceding Progress Report compiled in 1995. This report therefore emphasizes those aspects not reported in the earlier report.

4.1.3. Materials and Methods

The study was conducted at the University of Nairobi's Kabete field station. Plants of the white-seeded sesame landrace were grown in 30 cm diameter pots filled with three different planting media and subjected to five levels of N and five levels of P in a 5x5x3 factorial experiment laid out in a completely randomized block design. The planting media included unsterilized field soil (M_1), acid washed sand (M_2) and sterilized field soil (M_3). The field soil (top 20 cm) was collected from Siaya Farmers Training Centre (FTC) where sesame has not shown response to applied N and P over a period of six seasons. Nitrogen and Phosphorus levels were applied as multiples of Hoagland solution. The N levels comprised:

N_0 - 0 Hoagland N

N_1 - ¼ Hoagland N

N_2 - ½ Hoagland N

N_3 - 1 Hoagland N

N_4 - 2 Hoagland N

Similarly the P levels comprised of:

P_0 - 0 Hoagland P

P_1 - ¼ Hoagland P

P_2 - ½ Hoagland P

P_3 - 1 Hoagland P

P_4 - 2 Hoagland P

The N and P contents at planting were 0.14% N and 29.8 ppm P (Mehlich) respectively while content of the two nutrients were negligible in the acid-washed sand medium.

To obtain the different N combinations, while keeping Ca and K constant, KCl and $CaCl_2$ were used to replace KNO_3 and $Ca(NO_3)_2$ respectively of the Hoagland solution. Different quantities of H_3PO_4 were used to vary the P levels. In the process of sterilization, 50 Kg batches of field soil sacks were loaded into steam autoclave and steam sterilized at a pressure of 2 bars (134°C) for 10 minutes after which it was cooled before being placed into planting pots which were then covered with aluminium foil to avoid contamination. Sand was washed thoroughly to remove all silt and clay by stirring and agitating the sand under running water. The water washed sand was then soaked for 48 hours in acid solution consisting of 3 parts concentrated sulphuric acid to 1000 parts water by volume. This process was necessary to remove all minerals. The acid was then poured off and the sand rinsed with water to neutral pH. Planting seeds were also sterilized by washing with 5 % sodium hypochlorite.

The experiment was terminated at 51 days after emergence at which time the sesame plants were in flowering stage. Biomass of the plants in each pot and the mycorrhizal infection rate were both determined at the time the experiment was terminated.

Biomass was determined by drying the above-ground parts of the plants in an oven at 80°C to constant weight. Mycorrhizal infection rate was determined on root samples. The roots were retrieved by gently washing out the potting media. The washed roots were strained and the infection rate established using the method described by Mason *et al.* (1991).

4.1.4. Results and Discussion

Analysis of biomass taken at 51 days after emergence (DAE) showed significant two way interaction among all the parameters. The interaction was highly significant ($P \leq 0.01$) for media and phosphorus and media and nitrogen but NP interaction was only significant at $P \leq 0.05$ level (Table 1). Essentially, both N and P application did not significantly affect biomass in M_1, but in M_2 and M_3, biomass increased with increasing application of both nutrients. In the NP interaction (Table 2) there was no significant N effect at P_0, P_1 and P_3 but biomass increased with increasing N levels at P_4 level.

Mycorrhizal analysis showed roots in M_1 to be highly infected 95.7%/cm as opposed to M_2 and M_3 in which roots were barely infected at 0.10%/cm (Table 3).

Table 1: Effect of planting media and N and P fertilizers on biomass of sesame (g/plant) at 51 DAE. (Trial 2)

		P_0	P_1	P_2	P_3	P_4	N mean
M_1	N_0	18.5	23.4	17.4	36.3	22.6	23.6uvwx
	N_1	13.0	10.5	29.4	16.5	16.5	17.2wxyz
	N_2	21.2	23.1	26.5	24.6	24.0	23.9uvw
	N_3	24.7	15.3	22.5	23.6	23.6	21.9vwxy
	N_4	18.1	23.1	17.7	16.2	16.2	18.2wxyz
PM_1 mean		19.2vw	19.1vw	22.7vw	23.4vwx	20.6vw	
M_2	N_0	0.3	1.7	5.6	8.0	11.2	5.4z
	N_1	0.3	2.6	6.0	9.5	17.5	7.2z
	N_2	0.2	3.3	6.6	9.6	22.6	8.5z
	N_3	1.0	3.5	7.2	13.9	26.9	10.5xyz
	N_4	1.2	5.1	7.9	15.3	53.4	17.0wxyz
PM_2 mean		0.6z	3.2z	6.7xyz	11.3wxyz	26.7v	
M_3	N_0	0.1	2.3	11.1	24.6	65.0	20.5vwxy
	N_1	0.1	3.2	14.3	32.6	77.2	25.5uvw
	N_2	0.3	5.6	16.1	37.7	94.5	31.8uv
	N_3	0.5	6.9	18.1	44.8	96.3	33.3u
	N_4	2.0	8.4	23.5	52.6	139.4	45.1t
PM_3 mean		0.6z	5.3yz	16.6vwxy	38.4u	94.4t	
P mean		5.6c	12.1c	14.2c	23.7b	47.4a	

	M	N	P	MN	MP	NP	MNP
F TEST	**	*	**	**	**	*	ns

C.V. = 116.9% SE = 2.8
*, ** Significant at 1% and 5% probability level respectively
ns Not significant

	M_1	M_2	M_3
M means	22.8b	9.6c	31.2a

	N_0	N_1	N_2	N_3	N_4
N means	16.5b	20.0ab	22.1ab	20.7ab	26.7a

Means followed by the same letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test.

Table 2: Effect of N and P fertilizers on biomass of sesame (g/plant) at 51 DAE. (Trial 2)

	P_0	P_1	P_2	P_3	P_4	N mean
N_0	6.3ij	9.1hij	11.4fghij	22.8defghi	32.9cde	16.5y
N_1	4.5j	5.4j	16.6fghij	19.3efghij	37.1bcd	20.0xy
N_2	7.2hij	10.7ghij	16.4fghij	23.6defgh	46.9bc	22.1xy
N_3	8.7hij	8.6hij	15.9fghij	27.4defg	48.9b	20.7xy
N_4	7.1hij	12.2fghij	16.3fghij	28.0def	70.2a	26.7x
P mean	8.6z	12.1z	14.2z	23.7y	47.4x	

C.V. = 78.1% SE = 3.2
$LSD_{0.05}$ P = 6.3 $LSD_{0.05}$ N = 6.3 $LSD_{0.05}$ NP = 5.0

Means followed by the same letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test.

Table 3: Effect of planting media and N and P fertilizers on mycorrhizal infection rate (% infection/cm) of sesame at 51 DAE. (Trial 2)

		P_O	P_1	P_2	P_3	P_4	N mean
M_1	N_0	95.1	98.4	99.0	92.3	97.0	96.4
	N_1	97.9	97.7	95.8	98.3	100.0	97.9
	N_2	95.8	98.6	98.2	97.4	99.0	97.8
	N_3	96.6	97.0	93.2	90.7	97.2	94.9
	N_4	80.0	98.3	98.6	99.1	83.0	91.7
PM_1 mean		93.1	98.0	97.0	95.6	95.3	
M_2	N_0	0.0	0.0	0.0	0.0	0.0	0.0
	N_1	0.0	0.0	0.0	0.0	0.0	0.0
	N_2	0.0	0.5	0.0	2.3	0.0	0.6
	N_3	0.0	0.0	0.0	0.0	0.0	0.0
	N_4	0.0	0.0	0.0	0.0	0.0	0.0
PM_2 mean		0.0	0.1	0.0	0.5	0.0	
M_3	N_0	0.0	0.0	1.5	0.0	0.0	0.3
	N_1	0.0	0.0	0.0	0.0	0.0	0.0
	N_2	0.0	0.0	0.0	0.0	0.0	0.0
	N_3	0.0	0.0	0.0	0.0	0.0	0.0
	N_4	0.0	0.0	0.0	0.0	0.0	0.0
PM_3 mean		0.0	0.0	0.3	0.0	0.0	
P mean		31.0a	32.7a	32.4a	32.0a	31.8a	

	M	N	P	MN	MP	NP	MNP
F TEST	**	ns	ns	ns	ns	ns	ns

C.V. = 18.2% SE = 5.3
*, ** Significant at 1% and 5% probability level respectively
ns Not significant

	M_1	M_2	M_3
M means	95.8a	0.1b	0.01b

	N_0	N_1	N_2	N_3	N_4
N means	32.2a	32.7a	32.8a	31.7a	30.6a

Means followed by the same letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test.

Analysis on sesame roots collected from the fields in Siaya showed high levels of VAM fungal infection (more than 90%/cm of root). Sesame root infection by VAM fungi has also been demonstrated by other workers (Sulochana and Manoharachary, 1990; Sulochana *et al.*, 1989; Vijayalakshmi and Rao, 1988; and Girijika and Nair, 1985). The phenomenon that VAM infection may increase growth of the host plants especially when the nutrient supply in the soil is low is, almost universally accepted (Dubey, 1993; Sulochana *et al.*, 1989; Yost and Fox, 1979; Sanders and Tinker, 1973; Voggo, 1971 and Harley, 1969). These nutrients would of course include nitrogen. Some authors however contend that this is only true for plants grown in soils low in phosphorous (Mason *et al.*, 1991; Marschner, 1986 and Yost and Fox, 1979). It is also well established that tissue concentrations of minerals (nitrogen included) especially phosphorous is higher in mycorrhizal than in non-mycorrhizal plants, and that the main advantage of mycorrhizal infection over non-infection is the increase in efficiency of uptake of nutrients from the soil. Stribley *et al.*(1980) suggested that increased carbohydrate utilization together with increased phosphate uptake in mycorrhizal plants means that these plants are carbon limited hence higher tissue mineral concentrations. This could explain why, even though all the plants were mycorrhizal, increase in the level of nutrients N and P did not significantly affect growth. It may also be explained that due to the heavy levels of mycorrhizal infection the plants exposed to lower levels of phosphorous and nitrogen were able to exploit those regimes of lower nutrient level which would normally be out of reach of non-mycorrhizal plants. Harley and Smith (1983) maintained that the importance of mycorrhizal infection to a particular variety or species host plant may depend on the phosphate concentration in the soil, the net affinities of root and fungal systems for phosphate and the phosphate requirement of the host. Low yield potential of sesame and infection of roots by VAM fungi or the combination of both these factors could be the reason why sesame grown in pots of unsterilized field soil from Siaya did not respond to nitrogen and phosphorous addition. Mycorrhizal infection of these roots could explain the higher growth and shoot biomass results obtained in pots with unsterilized soil as compared to acid washed sand and steam sterilized field soil. The biomass results indicated higher shoot dry matter (DM) at any given level of N in sterilized soil than in unsterilized soil and acid washed sand (Table 1). Similar observations were made by Abbot and Robson (1977) using P, where they found that in autoclaved soil but not in unsterilized soil, non-mycorrhizal subterranean clover showed higher shoot DM at a given level of P than mycorrhizal clover. According to Abbot and Robson (1977) the mycorrhizal response was eliminated by the addition of phosphate thus indicating that the response to N was linked with phosphate nutrition.

The significant growth response to nitrogen and phosphorous nutrition in the sterile media (acid washed sand and sterilized field soil) may be due to the fact that in these media the plant were not significantly mycorrhizal (less than 1%/cm infection) whereas in the unsterilized soil, plants were found to be heavily mycorrhizal. Since these non-mycorrhizal plants were exploiting the same source of nutrients, increase in the nutrient level gave rise to more availability of nutrients hence more uptake. Therefore plants in the more enriched media were able to show enhanced growth than those in the less enriched media.

Growth was higher in the sterilised soil than in sand though both had non-mycorrhizal plants. Sand generally has a poor water and nutrient holding capacity than clays, silts and loams. The field soil hence retained more of the nutrients supplied and the sesame plants could exploit them for a longer period. In addition the field soil though sterilized, have higher nutrient content (moderate) as compared to sand whose nutrient content was negligible. This is particularly true of essential nutrients other than N and P which were tested. Sesame plants in the soil thus had more complete nutrient environment to exploit and as such, even earlier in the season they showed superior growth than those in sand media.

The sand media had numerically, the lowest mean biomass throughout the growth season. Avnimelech and Scherzer (1972) reported that the level of phosphorous available to radish and lettuce plants during the first few days of growth was found to be critical for proper growth up to maturity and the change induced by deficiency, inhibit growth even if phosphorus is supplied later. In the soil media phosphorous was available right from the beginning of the experiment hence the plants responded normally when phosphorous was later added. In the sand however inadequate amount of phosphorous (due to rapid percolation into the sand) during early days of growth may have inhibited normal growth response when phosphorous was later added in greater amounts as shown by the growth values for sand grown plants. Biomass showed interaction of N and P to be significant. There was significant response to P at all levels while N response was only significant at the highest levels of P. This indicated that nitrogen nutrition of the plants were probably limited by P availability.

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4.2 GERMPLASM ACQUISITION AND VARIETAL DEVELOPMENT

4.2.1 Objectives

(i) Further germplasm collection initiated in phase I of Sesame (K) Project for sesame germplasm bank development.

(ii) Use of assembled germplasm and promising accessions identified in Phase I of Sesame (K) Project for development of disease resistant and high yielding varieties adapted to Coast Province and sesame growing areas of western Kenya.

4.2.2. GERMPLASM ACQUISITION

4.2.2.1. Materials and Methods

Within the last twelve months contacts were made for scientists in foreign institutions for the purpose of acquiring additional sesame germplasm.

4.2.2.2 Results

As a result of contacts with sesame researchers in India, Israel, and Turkey a number of sesame germplasm materials were obtained as follows, seven accessions from India, two accessions from Turkey and three accessions from

Iraq. These were accessions developed by mutation breeding in the respective countries. They have been incorporated into our sesame varietal development programme.

4.2.3. VARIETAL DEVELOPMENT

4.2.3.1 Field Screening of the Germplasm

4.2.3.1.1 Materials and Methods

In each season two experiments were conducted at Siaya Farmers' Training Centre (FTC) in Nyanza Province and the Kenya Agricultural Research Institute research centre at Mtwapa (Coast Province) and one experiment at the University of Nairobi Dryland Farming Research Station in Kibwezi (Eastern Province). One of the two experiments at Siaya and Mtwapa was a preliminary yield trial for promising sesame selection (Experiment I) while the other experiment (Experiment II) at the two sites and at Kibwezi was a preliminary screening/observation of germplasm which were yet to be advanced to yield trials after identification of promising genotypes among them. However, the experiments at Kibwezi were advanced to preliminary trials after the first two seasons of such observation. These experiments are described below.

4.2.3.1.1A Experiments at Siaya F.T.C.

(i) Experiment I

This experiment was conducted in four cropping seasons, namely October 1994 to February 1995, April to August 1995, October 1994 to February 1996 and April to August 1996. The number of cultivars subjected to preliminary yield trials in these seasons were 20, 21, 22, and 23 respectively. Among the cultivars tested was a local landrace selection, SIK 004 from western Kenya which was included as a check. In each season the trials were planted in a three replicate randomised complete design with each genotype being planted in a plot of four rows. The spacing between the rows was 50 cm while within the rows the plants were spaced at 20 cm. With row length of 4m the size of each plot was 1.5m by 4m. The data were obtained at maturity for the following traits:

1) Plant height
2) Height to first capsule on the main stem
3) Length on main stem from first capsule to tip
4) Mean capsule length
5) Mean capsule width
6) Number of capsules per plant
7) Seed yield.

Capsule measurements were taken on the first three capsules on the main stem and the mean obtained. The experiments were weeded twice and no fertilizer was applied. The data from each season was analyzed separately.

(ii) Experiment II

Twenty-eight sesame accessions from the germplasm stock were subjected to preliminary observation at Siaya during the cropping seasons of October 1994 to February 1995, April to August 1995, October 1995 to February 1996 and April to August 1996. In each season the accession were planted in a two replicate randomised complete block design with two rows per accession. The row length spacing between the two rows and within the rows were maintained as above, therefore giving plot size of 4m by 1m for each accession. The data were obtained for the same traits as above.

4.2.3.1.1B Experiments at Mtwapa

(i) Experiment I

Sixteen promising sesame genotypes previously selected at Mtwapa were planted at the same site for preliminary yield trial Mtwapa during October 1994 to February 1995 season. A local selection from Coast Province, SIK 016, was planted as a check variety. The trial was planted in a three replicate randomised complete block design with each entry being planted in a plot of four rows. The row length, spacing between the rows and within the rows were maintained as above, hence

Table 4: Analysis of variance mean squares for preliminary yield trials (Experiment I) conducted at Siaya FTC.

Season	Source	df	Plant height (cm)	First capsule height (cm)	Length on main stem from first capsule to tip (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Yield (Kg/ha)
Oct. 1994 to Feb. 1995	Varieties	19	60.7	53.5**	51.2*	0.058**	0.043**	56	45342.8
	Error	38	44.8	17.2	24.3	0.015	0.012	91	32217.2
April to Aug. 1995	Varieties	20	196.64**	212.50**	46.60	0.146**		455**	136980.11**
	Error	40	69.09	26.52	41.10	0.037		154	42378.26
Oct. 1995 to Feb. 1996	Varieties	21	166.00**	68.90**	98.07**	0.063**	0.015**	165**	7167.03**
	Error	42	59.03	21.32	31.9	0.019	0.006	45	2138.77
April to Aug. 1996	Varieties	21	107.76	286.53**	108.80	0.1733**	0.0090**	376	86741.92**
	Error	42	213.30	42.67	83.45	0.0136	0.0012	323	33056.70

*, ** Significant $P \leq 0.05$ and 0.01 respectively

Table 5: Mean performances of the cultivars in preliminary yield trials (Experiment I) at Siaya FTC during October 1994 to February 1995.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Days to Flower	Length on main stem from first capsule to tip (cm)	Yield per ha. (Kg)
SPS SIK 110	95.4	43.8	2.33	0.78	69	47	51.6	541.3
SPS SIK 28	108.2	56.9	2.57	0.70	58	51	51.2	391.3
SIK 019 Br	108.9	52.7	2.56	0.64	62	51	56.3	653.3
SPS SIK 16	110.1	56.2	2.63	0.70	57	51	54.3	730.3
SIK 004	107.3	46.0	2.57	0.68	62	46	61.3	767.3
SPS SIK 113	111.5	53.7	2.68	0.67	61	47	61.2	487.3
SIK 067	105.2	42.3	2.56	0.67	67	43	62.9	581.0
SPS SIK 31	104.9	50.0	2.40	0.94	62	50	55.0	596.0
TANU 22	109.8	51.6	2.57	0.70	60	43	58.4	862.3
SPS SIK 6	113.3	48.7	2.16	1.00	67	47	64.6	422.7
SPS SIK 12	105.2	41.9	2.68	0.68	63	44	61.6	439.3
SIK 016	105.0	50.1	2.42	0.87	64	50	55.0	603.7
SIK 092	104.4	52.3	2.67	0.72	59	45	52.0	581.3
SPS SIK 29	104.5	51.4	2.63	0.87	60	50	53.2	472.0
SPS SIK 116	98.9	46.7	2.67	0.68	57	50	53.6	483.3
SPS SIK Z3	102.0	48.0	2.40	0.65	71	50	54.1	453.7
SPS SIK 25	101.8	49.5	2.70	0.67	61	50	52.3	686.3
SPS SIK 93/008	104.4	45.7	2.58	0.65	71	51	58.7	608.7
SIK 108	103.9	50.7	2.55	0.60	63	47	55.3	534.0
SIK 019	98.4	45.4	2.48	0.97	57	47	53.0	517.7
MEAN	105.2	49.2	2.54	0.74	62	48	56.3	570.7
$LSD_{0.05}$	11.0	6.8	0.20	0.18	15.74		8.1	296.7

giving plot sizes of 4m by 1.5m for each genotype. The data were scored for the same traits as above at maturity and the mean number of capsules on the main stem.

(ii) Experiment II

Twenty accessions from the sesame germplasm stock were subjected to preliminary observation screening at Mtwapa between October 1994 and February 1996. The trial was planted in a two replicate randomised complete block design with two rows per accession. The spacing between the rows and within the rows were maintained as above. Since the rows were 4m long the plot size for each accession was 4m by 1m. The data were take for the same traits as above.

4.2.3.1.1C. Experiments at Kibwezi

At Kibwezi 43 and 30 accessions were subjected to preliminary observation screening during November 1994 to March 1995 and May to September 1995 respectively.

From these screening observations nineteen promising genotypes were selected for preliminary yield trials in November 1995 to March 1996 and May to September 1996. Weeds were adequately controlled and supplemental irrigation was supplied when necessary.

The experiments were planted in randomised complete block design with row length of 4m. The spacing between the rows and within the rows were 50 cm and 20 cm respectively. The experiments of the first two seasons were replicated two times with each accession having a plot of two rows. The experiments of November 1995 to March 1996 and May to September 1996 were replicated three times with each accession being planted in a plot of 3 rows. In each season (except May to September 1996) the data were collected on the same traits as above and mean number of capsules on the main stem. In the season of May to September 1996 the trials were so badly damaged by nematode attack that no data were taken.

4.2.3.1.2 Results and Discussion

4.2.3.1.2A Experiments at Siaya FTC

(i) Experiment I

The twenty cultivars subjected to on-station preliminary yield test at Siaya during October 1994 to February 1995 were significantly different among themselves for first capsule height on the main stem, length on the main stem from first capsule to stem tip, mean capsule length and mean capsule width (Table 4). The mean plant height was 105.2 cm with the tallest cultivars being SPS SIK 6, SPS SIK 113 and SPS SIK 16 (Table 5). Generally only half of the main stem length or less had capsules as reflected by length on main stem from first capsule to tip. The tallest cultivars also had the longest stretch on the main stem from first capsule to stem tip and the highest first capsule height. This was confirmed by generally high positive correlations between these two traits and plant height (Table 6). Positive correlations involving these traits have also been observed by Manivannan *et al.*, (1993) and Kumar *et al.*, (1993).

In sesame breeding low first capsule height is preferred since it is believed to lead to high seed yields (Hoballah, 1996 and Ashri 1988). In this study first capsule height had positive significant correlation with seed yield during the season of October 1994 to February 1995. Similar relationships between these traits have been reported by Kumar *et al.*, (1993) and El-Shimy and El-Hifny (1989).

Since the plant size parameters (plant height, height to first capsule, length on the main stem from first capsule to stem tip) had only moderate or no associations to seed yield not all those cultivars that were tall or had high first capsule placement had high seed yields (Table 6). For example the tallest SPS SIK 113 and SPS SIK 6 which also had high first capsule placements had very low seed yields (Table 5). The mean first capsule height was 49.2 cm. This is very high as compared to the recommended 20 to 30 cm (Ashri, 1988). However this recommendation may be more applicable to the unbranched cultivars which have no capacity to compensate should there be low capsule production on the main stem. All the cultivars tested in this experiment were the branching type and had one capsule per axil. The capsules were generally long with the mean capsule length being 2.54cm. The longest

Table 6: Phenotypic correlations among the trials studied in preliminary yield trials (Experiment I) at Siaya FTC

Trait	Season	First capsule height	Length on main stem from first capsule to tip	Capsule length	Capsule width	Capsules per plant	Seed yield per plant
Plant height	I	0.69**	0.59**	0.10	0.00	0.15	0.44**
	II	0.69**	0.68**	0.42**	-0.15	0.66**	0.60**
	III	0.58**	0.69**	0.59**	0.10	0.66**	0.53**
	IV	0.57**	0.69**	0.34*	-0.02	0.65**	0.42**
First capsule height	I		-0.13	0.16	-0.05	-0.10	0.30*
	II		0.00	0.32*	0.05	0.42**	0.32*
	III		0.07	0.41**	0.19	0.23	0.27
	IV		-0.08	0.20	-0.30*	0.43**	0.25
Length on main stem from first capsule to tip	I			-0.03	0.02	0.25	0.25
	II			0.24	-0.29	0.55**	0.53**
	III			0.41**	-0.01	0.75**	0.58**
	IV			0.27	0.33*	0.55**	0.46**
Capsule length	I				-0.46**	0.00	0.17
	II				-0.34*	0.37*	0.28
	III				-0.30*	0.53**	0.47**
	IV				-0.30*	0.35*	0.20
Capsule width	I					-0.11	-0.21
	II					-0.32*	-0.13
	III					-0.17	-0.16
	IV					0.16	0.34*
Capsules per plant	I						0.16
	II						0.53**
	III						0.53**
	IV						0.58**

Season I, II, III and IV are Oct. 1994 - Feb. 1995, March - Aug. 1995, Oct. 1995 - Feb. 1996 and March - Aug 1996 respectively

*, ** Significant $P \leq 0.05$, 0.01 respectively.

capsules were observed on SPS SIK 25, SPS SIK 113, SPS SIK 12, SIK 092 and SPS SIK 116. Since capsule length and capsule width were negatively related (Table 6) the cultivars with long capsules generally had narrow capsules. These two traits did not have any significant correlation to seed yield. However, the study reported by El-Shimy and El-Hifny indicated that these capsule size parameters and yield were positively interrelated.

During the October 1994 to February 1995 highest seed yields were obtained from TANU 22, the landrace SIK 004, SPS SIK 16 and SPS SIK 25. Though Table 4 suggests that there was no variation among these cultivars Duncan's multiple range and least significant difference tests suggested that some cultivars out yielded others. Thus the TANU 22 did significantly better than SPS SIK 28, SPS SIK 6 and SPS SIK 12.

During the preliminary yield test conducted at Siaya in April to August 1995 the 21 cultivars tested were significantly variable among themselves for most of the agronomic traits studied (Table 4). However the analysis of variance revealed no significant variation among the cultivars for length on main stem from first capsule to tip and capsule width. The average plant height and first capsule height were 111.8 cm and 45.9 cm respectively (Table 7). The tallest cultivars were SIK 019Br, TANU 22, SIK 004, SPS SIK Z3 and SPS SIK 113. These cultivars also had the highest first capsule

Table 7: Mean performances of the cultivars in preliminary yield trials (Experiment I) at Siaya FTC in April to August 1995.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Length on main stem from first capsule to tip (cm)	Yield per ha. (Kg)
SPS SIK 110	116.6	47.4	2.47	0.8	99	69.2	905
SPS SIK 28	112.2	49.3	2.65	0.9	85	60.5	948
SIK 019 Br	123.9	54.0	2.80	0.8	79	69.6	643
SPS SIK 16	115.4	48.2	2.88	0.8	83	67.2	930
SIK 004	118.6	50.0	2.72	0.8	76	67.9	707
SPS SIK 113	117.9	50.3	2.91	0.9	81	66.9	618
SIK 067	102.8	35.2	2.31	0.8	69	67.2	704
SPS SIK 31	107.3	47.6	2.32	0.9	70	59.7	537
TANU 22	121.9	54.0	2.70	0.8	86	68.3	829
SPS SIK 6	100.2	43.3	2.24	1.0	50	57.3	501
SPS SIK 12	105.7	40.1	2.85	0.8	71	65.6	506
SIK 016	104.4	45.2	2.64	0.9	54	59.3	437
SIK 092	113.4	44.4	2.73	0.8	81	70.1	860
SPS SIK 29	109.6	48.2	3.07	0.8	80	61.5	977
SPS SIK 116	116.8	50.0	3.07	0.8	72	66.8	579
SPS SIK Z3	119.9	56.6	2.67	0.8	85	63.7	813
SPS SIK 25	106.7	45.5	2.73	0.8	91	60.7	696
SPS SIK 93/008	112.6	44.0	2.65	0.8	82	68.3	752
SIK 108	117.7	48.1	2.76	0.8	86	69.6	849
SIK 131	90.7	15.5	2.58	0.8	55	66.9	67
SIK 019	114.3	47.3	2.58	1.0	76	67.0	746
MEAN	111.8	45.9	2.68	0.84	77	65.4	665
$LSD_{0.05}$	13.7	8.5	0.32		20	10.6	340

height. Generally the tall cultivars had high first capsule placements since plant height and first capsule height had strong positive correlations. The shortest cultivar, SIK 131, had the lowest first capsule placement. This cultivar was non-branching and had three capsules per axil. The first capsule placement for this cultivar was 15.5 cm as compared to the recommended first capsule height of 20-30 cm. The stretch along the main stem from the first capsule to stem tip was at least 57 cm for all the cultivars. The values for this trait ranged from 57.3 cm to 70.1 cm with a mean of 65.4 cm (Table 7). As already indicated there was no significant variation among the cultivars for this trait during April-August 1995 season. However, like the other plant size measurement traits this character had a positive relationship to seed yield (Table 6). Among the height measurement traits plant height had the highest positive correlation to seed yield. Tall plants have also been shown to be higher yielding than shorter ones by Biswas and Akbar (1995), Manivannan *et al.*, (1993) Thangavelu and Shridharan (1988). Capsule size measurements were not significantly related to seed yield. This is in contrast to the observations of Kumar *et al.*, (1993), Vanisri *et al.* (1994) and El-Shiny and El-Hifny (1989) which revealed that capsule length correlated positively to yield. The capsules were generally long among the cultivars, with the mean of 2.68 cm and the values ranging from 2.24 cm and 3.07 cm. The longest capsules were observed on SPS SIK 29, SPS SIK 116 and SPS SIK 113 while the shortest capsules were on SPS SIK 16 and SIK 067 and SPS SIK 31. The mean number of capsules per plant was 77. Generally the cultivars with high capsule number like SPS SIK 110, SPS SIK 28, SPS SIK 16, SIK 108 and SIK 092 had high seed yields. Thus capsule number and seed yield were positively correlated (Table 6). Such correlations were also reported by Kandasany *et al.* (1991), Chen-hua and Jing-Ze (1988) and Manivannan *et al.* (1993). The cultivars with the highest yields namely SPS SIK 29, SPS SIK 28, SPS SIK 16 and SPS SIK 110 had yields of at least 900 kg/ha. The disease resistant SPS SIK 113 which is already a choice of many farmers in Siaya district gave only a moderate yield of 618 kg/ha. The lowest yields were obtained from the unbranched SIK 131 having three capsules per axil. This cultivar which is of Chinese origin was heavily attacked by *Cercospora* and *Alternaria* leaf spots and wilts at Siaya. This was probably responsible for its poor performance. The landrace SIK 004 also gave a moderate yield of 707 kg/ha, which was slightly better than the overall mean yield of 665 kg/ha.

In the October 1995 to February 1996 season twenty two cultivars were tested. They were highly variable for all the traits studied (Table 4). The mean plant height and first capsule height and first capsule height were 73.5 cm and 37.1 cm respectively with the tallest cultivars being SIK 092, SPS SIK Z3, SPS SIK 116, SPS SIK 25 and SPS SIK 28. Since there was a strong positive correlation between plant height and first capsule height these cultivars were also among those with the highest first capsule placement (Tables 6 and 8). The tallest plants also had the longest stretch on the main

Table 8: Mean performances of the cultivars in preliminary yield trials (Experiment I) at Siaya FTC in October 1995 to February 1996.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Length on main stem from first capsule to tip (cm)	Yield per ha. (Kg)
TANU 22	73.1	42.0	2.45	0.80	32	31.1	153
SIK 004	74.1	41.5	2.44	0.80	37	32.6	95
SIK 016	70.6	41.4	2.16	0.80	22	28.7	53
SIK 019	76.0	36.4	2.23	0.87	39	39.6	148
SIK 019 Br	62.3	32.7	2.17	0.80	24	25.4	31
SIK 067	76.0	34.2	2.29	0.70	38	42.2	80
SIK 092	81.3	37.3	2.50	0.70	38	44.0	203
SIK 108	75.4	39.6	2.37	0.70	31	35.8	75
SIK 131	73.2	30.0	2.36	0.77	36	42.8	120
SPS SIK Z3	82.9	42.8	2.37	0.80	46	40.1	106
SPS SIK 110	75.1	35.8	2.34	0.80	41	39.7	114
SPS SIK 113	75.2	36.4	2.41	0.80	30	38.5	84
SPS SIK 116	83.3	44.9	2.69	0.73	38	38.4	134
SPS SIK 12	61.9	32.7	2.27	0.70	26	29.2	61
SPS SIK 16	68.8	38.0	2.21	0.80	28	30.8	69
SPS SIK 25	81.5	41.6	2.51	0.80	40	39.6	167
SPS SIK 28	81.5	43.2	2.42	0.80	40	38.3	159
SPS SIK 29	72.6	30.2	2.30	0.80	31	32.4	86
SPS SIK 31	80.0	38.6	2.19	0.90	32	41.4	156
SPS SIK 50/1	54.0	27.0	2.22	0.70	24	27.0	22
SPS SIK 6	66.3	36.8	2.04	1.00	17	29.4	42
SPS SIK 93/008	72.9	34.0	2.34	0.80	38	40.8	139
MEAN	73.5	37.1	2.33	0.78	33	35.8	104
$LSD_{0.05}$	12.7	7.6	0.22	0.04	11	9.3	76

stem from first capsule stem tip. This was particularly so for SIK 092 and SPS SIK Z3. The two traits were strongly correlated. As compared to the first two seasons the plants were much shorter in the October 1995 to February 1996. This season was generally drier than the first two seasons hence leading to poorer performance in most of the traits. Of the plant size traits, plant height and length on main stem from first capsule to stem tip had significant positive associations to seed yield. The plant size and seed yield were also strongly related to capsule length but not to capsule width. Thus cultivars like SIK 092, SPS SIK 116 and SPS SIK 25 had quite long capsules. Positive relationships between capsule length and seed yield have also been reported by Kumar *et al.* (1993), Vanisri *et al.* (1994) and El-Shiny and El-Hifny (1989). Capsule number was also strongly related to plant height, length on main stem from first capsule to stem tip, capsule length and seed yield. Positive relationships between capsule number and these traits have been reported by Vanisri *et al.* (1994), Biswas and Akbar (1995), Manivannan *et al.* (1993) Ibrahim (1989) and Hoballah (1996). Tall plants are expected to have more capsules because probably they have more space on themselves for bearing the capsules and have more photosynthetic capacity for supporting such capsules since they have more foliage than the shorter cultivars. Given similar plant architecture the taller plants would therefore give more yields than the shorter ones because of such advantages. Thus some tall cultivars like SIK 092, SPS SIK Z3, SPS SIK 116, SPS SIK 25 had fairly high capsule numbers (Table 8).

Similarly, the high yielding SPS SIK 092, SPS SIK 25, SPS SIK 28 and SPS SIK 31 were among the tallest and most of them had high capsule number. Capsule width had no correlation to any of the traits though there was substantial variation among the cultivars for capsule size measurement (Table 6).

The data presented in Table 9 suggest that the cultivars performed much better in the April to August 1996 season than the preceding seasons. The plants were taller and had higher first capsule placements. According to analysis of variance in Table 4, there were significant variations among the cultivars for first capsule height, capsule length, capsule width and seed yield per hectare only. However according to Duncan's multiple range and least significant difference tests SPS SIK 113 was taller than SPS SIK 29. The mean first capsule height was 59 with the highest first capsule placement being observed on SIK 019Br. A generally short cultivar SIK 131 had the lowest first capsule placement (Table 9). As was observed in the first three seasons plant height was positively related to all traits except capsule width (Table 6). Thus tall plants had high first capsule placements, long capsules, higher capsule number, average seed yields and longer stretch on the main stem from first capsule to stem tip. Hence the tall cultivars with high first capsule heights and/or long stretches on the main stem from the first capsule to the tip

Table 9: Mean performances of the cultivars in preliminary yield trials at Siaya FTC in April to August 1996.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Length on main stem from first capsule to tip (cm)	Yield per ha. (Kg)
TANU 22	131.8	64.7	2.86	0.89	83	68.4	593
SIK 004	132.7	60.7	2.83	0.88	97	75.5	690
SIK 016	131.7	56.7	2.84	0.87	86	74.2	434
SIK 019	124.9	54.2	2.73	0.96	89	72.3	768
SIK 019 Br	137.3	75.4	2.82	0.85	93	61.1	635
SIK 067	130.3	57.5	2.83	0.89	74	72.8	624
SIK 092	128.2	63.2	2.91	0.92	89	70.6	676
SIK 108	134.4	65.6	2.75	0.84	79	69.0	710
SIK 131	126.8	30.1	2.85	0.88	69	83.3	262
SPS SIK Z3	132.9	75.1	2.67	0.80	87	58.1	565
SPS SIK 110	123.5	51.4	2.75	0.92	88	72.5	593
SPS SIK 113	140.0	58.4	2.97	0.90	115	81.4	741
SPS SIK 116	138.1	61.7	3.72	0.80	97	76.4	985
SPS SIK 12	135.5	70.3	2.92	0.84	93	65.2	621
SPS SIK 16	133.1	55.7	2.96	0.92	89	74.8	707
SPS SIK 25	136.0	65.6	2.89	0.89	94	70.5	763
SPS SIK 28	124.0	58.6	2.84	0.93	83	65.5	782
SPS SIK 29	117.1	44.4	2.53	1.00	73	72.3	635
SPS SIK 31	134.4	57.2	2.78	0.93	88	77.2	741
SPS SIK 50/1	121.9	55.8	2.76	0.80	59	66.0	211
SPS SIK 6	122.9	53.1	2.37	0.98	89	74.3	749
SPS SIK 93/008	130.3	62.2	2.69	0.84	84	68.2	534
MEAN	130.4	59.0	2.83	0.89	86	71.3	637
$LSD_{0.05}$	24.1	10.8	0.19	0.06	30	15.1	300

were SIK 0192Br, SIK 108, SPS SIK 113, SPS SIK 116, SIK 004, SPS SIK 12, SPS SIK 25 and SPS SIK 31. Also the cultivars with high capsule number were SIK 004, SIK 019Br, SPS SIK 113, SPS SIK 116, SPS SIK 12 and SPS SIK 25. Since capsule number had only a moderate relationship to seed yield (Table 6) not all the high yielding cultivars had the highest capsule number (Table 9). Thus the best yielding cultivars, SPS SIK 116, SPS SIK 28, SIK 019, SPS SIK 25, SPS SIK 6, SPS SIK 31 and SPS SIK 113 had variable performances with respect to capsule number. Some of them had capsule numbers that were lower than the overall mean. The capsules were longer and wider as compared to the first three seasons. The two traits were negatively interrelated.

Based on the four seasons of preliminary yield trials it is evident that the cultivar performances varied highly with the season and that their relative rankings varied from one season to another. The general poor performance in October 1995 - February 1996 seasons and general good performance in April to August 1996 suggest that sesame needs adequate rainfall for good yields. Extremely low rains leads to very poor performance. October 1994 to February 1995 and October 1995 to February 1996 were short rains seasons while April to August 1995 and April to August 1996 were long rains seasons. More rain is always realised during the long rains season than during the short rains season in western Kenya. The performances in the short rain seasons were generally lower than the performances during the long rains seasons (Table 5, 7, 8, 9). This suggests that to maximise the performance of the cultivars tested here, the cropping season may be restricted to the long rains season. However the farmers can still get a good crop if the short rains season as a moderate rainfall.

Based on the four seasons of preliminary yield tests at Siaya twelve cultivars may be selected for replicated yield trials. These are enlisted in Table 10. Selection is based on consistency of performance as being the best 10 cultivars during the four seasons. Those which appeared among the best ten for more than one season were selected and included in the list of cultivars to be subjected to replicated yield tests. Cultivar SPS SIK 113 has been included because farmers who have taken seeds from our project based on their observations of our field experiments have always preferred this cultivar. It has a distinctive pinkish coloration in its post flowering stage. It is also generally disease-free in the field. It has a good stability and is resistant to lodging. These are probably the traits which have made farmers prefer it to the higher yielding genotypes. Of the cultivars enlisted as promising in Table 10 SPS SIK 25, TANU 22, SPS SIK 16, SPS SIK 31, SIK 004, SPS SIK 93/008, SPS SIK 116, SIK 019 and SIK 108 were also enlisted in our previous report as good performing (Ayiecho and Nyabundi, 1995).

Table 10: Sesame cultivars selected for replicated yield tests based on results of preliminary yield tests (Experiment I) at Siaya FTC

Cultivar	Type of genotype/parent	Original source
SIK 092	Obtained as cultivar B2 from IDRC Oilcrops Network	Mexico
SPS SIK 28	Line selection from local landrace bulk	Nyanza Province, Kenya
SPS SIK 25	Line selection from landrace bulk	Nyanza Province, Kenya
TANU 22	Obtained as a cultivar from IDRC Oilcrops Network	Tamil Nadu University, India
SPS SIK 16	Line selection from MI	From Mtwapa - KARI
SPS SIK 31	Line selection from local landrace bulk	Nyanza Province, Kenya
SIK 004	Landrace	Nyanza Province, Kenya
SPS SIK 93/008	Selected from SPS SIK 95 (line from NCS111)	NCS is a local landrace from Nyanza Province, Kenya
SPS SIK 116	Line selection from local landrace bulk	Nyanza Province, Kenya
SIK 019	Landrace	Coast Province, Kenya
SIK 108		
SPS SIK 110	Line selection from landrace bulk	Nyanza Province, Kenya
SPS SIK 113	Line selection from local landrace bulk	Nyanza Province, Kenya

(ii) Experiment II

Apart from the short SPS SIK 1x most of the accessions tested in this experiment during October 1994 to February 1995 season did not have significant differences among themselves (Table 11). The tallest cultivars were SPS SIK 93/009, SIK 031 and SPS SIK 112. Since plant height was significantly ($P \leq 0.05$) related to first capsule height ($r = 0.87$) the tall cultivars tended to have high first capsule height. Plant height had significant ($P \leq 0.05$) positive relationships to most of the traits. Hence most tall cultivars had long capsules ($r = 0.74$) and high capsule number per plant ($r = 0.70$). The tall cultivars like SPS SIK 93/2/003, SPS SIK 73, SPS SIK 36, SIK 031, SPS SIK 112, SPS SIK 122 and SPS SIK 93/2/004 had high first capsule placement and/or long capsules. Other cultivars with long capsules were SPS SIK 1, SPS SIK 5, SPS SIK 3 and SPS SIK 51. Improved sesame cultivars should have low first capsule placement. Therefore cultivars like SPS SIK 101/1001, SPS SIK 1X, SPS SIK 10, SIK 013, SPS SIK 51, SPS SIK 91 and SPS SIK 96 would be expected to have high capsule number and therefore higher yielding since it has been observed that these characters are generally strongly interrelated (Hoballah, 1996, Kumar *et al.* 1993 and Manivannan *et al.* 1993). In this study these traits had significant ($P \leq 0.05$) interrelations but the relationships were only of moderate magnitudes i.e. first capsule height and capsule number; $r = 0.55$ first capsule height and seed yield; $r = 0.42$, and capsule number and seed yield $r = 0.47$). Thus not

Table 11: Mean performances of the cultivars in Experiment II at Siaya FTC in October 1994 to February 1995.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Yield per plant (g)
SPS SIK 51	87.0	36.2	2.56	0.67	47	3.28
SPS SIK 45	96.2	37.1	2.52	0.65	61	4.14
SPS SIK 1	88.2	40.2	2.63	0.67	56	4.57
SPS SIK 47	88.8	40.8	2.48	0.65	55	4.61
SPS SIK 101/001	67.8	27.9	2.33	0.70	38	2.34
SPS SIK 91	87.7	36.5	2.51	0.67	45	3.50
SPS SIK Z1	93.3	43.4	2.50	0.69	69	4.50
SPS SIK 93/2/003	99.9	48.4	2.21	0.99	63	4.01
SPS SIK 73	96.1	44.9	2.50	0.74	48	3.11
SPS SIK 93/009	100.5	44.5	2.39	0.82	67	5.08
SPS SIK 10	79.0	33.7	2.41	0.72	47	4.38
SPS SIK 1X	52.1	20.3	1.30	0.33	32	4.78
SPS SIK 51X	91.2	44.7	2.68	0.71	47	3.98
SPS SIK 23	94.7	45.1	2.44	0.71	62	2.52
SPS SIK 36	99.4	48.9	2.41	0.70	54	5.52
SPS SIK 23X	90.9	51.4	2.38	0.71	45	7.88
SPS SIK 36X	97.6	44.1	2.48	0.69	62	4.14
SIK 031	100.2	49.5	2.60	0.67	55	4.93
SPS SIK 112	102.1	48.1	2.64	0.75	64	6.42
SPS SIK 93/001	90.5	38.9	2.50	0.73	84	6.12
SPS SIK 96	80.7	36.5	2.45	0.70	69	5.72
SPS SIK 122	99.6	50.7	2.68	0.74	75	6.10
SPS SIK 93/2/004	98.5	47.0	2.71	0.70	70	4.85
SPS SIK 93/2/002	81.1	38.2	2.12	0.96	34	2.61
SPS SIK 93/007	83.7	37.1	2.52	0.69	56	4.59
SIK 083X	92.3	44.6	2.50	0.70	54	3.88
SPS SIK 3	94.2	47.9	3.04	0.60	59	4.63
SIK 013	93.1	36.9	2.38	0.67	61	5.04
MEAN	90.2	41.5	2.45	0.70	56	4.54
$LSD_{0.05}$	35.9	14.1	0.71	0.20	38	5.02

all the prolific cultivars (in terms of capsule production) like SPS SIK 45, SPS SIK Z1, SPS SIK 93/2/003, SPS SIK 93/009, SPS SIK 23, SPS SIK 36, SPS SIK 112, SPS SIK 93/001, SPS SIK 96, SPS SIK 122 and SPS SIK 93/2/004 had high seed yields per plant. The highest seed yields were observed only for SPS SIK 93/009, SPS SIK 36, SPS SIK 23X, SPS SIK 112, SPS SIK 93/001, SPS SIK 96, SPS SIK 122 and SIK 013. Like the other agronomic traits capsule length had moderate significant ($P \leq 0.05$) relationship to seed yield per plant ($r = 0.35$) while capsule width had no significant relations to seed yield.

The cultivars performed much better in nearly all traits during the April to August 1995 season than in October 1994 to February 1995 season. This is so because the April to August 1995 season was more favourable because of more rainfall. The plants were much taller with the mean plant height, first capsule height and length on main stem from first capsule to tip being 110.7 cm, 49.3 cm and 61.0 cm respectively (Table 12). Plant height had strong ($P \leq 0.05$) positive correlations with first capsule height ($r = 0.66$) and length on main stem from first capsule to stem tip ($r = 0.69$). Hence the tall cultivars like SPS SIK 122, SPS SIK 119, SPS SIK 51 and SPS SIK 083x had first capsule height and/or long stretches on main stem from first capsule to stem tip. Apart from the differences between the shortest SIK 031, SPS SIK 93/2/002 and SPS SIK 51x and the tallest SPS SIK 122 most cultivars did not have significant differences among themselves (Table 12). The cultivars with the highest first capsule height were SPS SIK

Table 12: Mean performances of the cultivars in Experiment II at Siaya FTC in April to August 1995.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Length on main stem from first capsule to tip (cm)	Yield per plant (g)
SPS SIK 122	122.9	47.0	3.05	0.80	89	65.7	8.45
SPS SIK 1	119.0	50.5	3.12	0.75	83	68.1	5.60
SPS SIK 3	112.3	57.3	3.07	0.70	72	55.1	4.25
SPS SIK 93/007	107.1	45.5	2.72	0.80	80	61.8	4.80
SPS SIK 23	104.2	50.5	2.77	0.80	57	53.6	5.00
SPS SIK 51	118.2	45.6	2.85	0.80	81	72.0	10.7
SPS SIK 36	109.0	47.0	2.55	0.80	85	62.0	3.70
SPS SIK 1X	107.6	53.5	2.75	0.70	61	53.6	6.45
SPS SIK 93/2/002	103.1	44.5	2.07	1.00	66	58.7	5.00
SPS SIK 93/009	111.3	50.9	2.67	0.80	67	60.4	5.30
SIK 031	97.2	41.1	2.65	0.70	53	56.1	2.80
SPS SIK 96	111.5	52.3	2.50	0.80	66	59.0	3.70
SIK 013	112.0	44.4	2.43	0.70	68	67.7	4.40
SPS SIK 93/2/003	106.1	43.9	2.70	0.90	72	62.2	5.90
SPS SIK 51X	102.3	43.0	2.71	0.70	69	59.3	3.70
SPS SIK 112	109.3	50.8	2.72	0.80	77	58.6	4.90
SPS SIK 91	107.7	55.4	2.47	0.80	67	52.3	3.15
SPS SIK 101/001	108.2	43.6	2.63	0.80	53	64.7	1.95
SPS SIK 93/2/004	106.7	46.7	2.82	0.80	69	60.4	3.35
SPS SIK Z1	108.5	46.8	2.61	0.70	86	61.8	4.20
SPS SIK 45	113.3	46.6	2.75	0.70	75	66.7	6.45
SPS SIK 10	113.1	49.8	2.85	0.80	79	62.8	8.75
SPS SIK 47	122.1	56.8	2.70	0.40	84	65.4	9.15
SPS SIK 93/001	115.0	51.3	2.67	0.80	101	63.3	7.80
SPS SIK 73	112.6	49.5	2.70	0.80	79	63.1	7.50
SPS SIK 083X	118.2	58.4	2.62	0.80	66	59.8	3.50
SPS SIK 23X	113.4	53.0	2.61	0.80	60	60.4	1.75
SPS SIK 36X	108.8	54.8	2.60	0.80	65	53.6	6.85
MEAN	110.7	49.3	2.69	0.77	72	61.0	5.32
$LSD_{0.05}$	18.5	10.3	0.39	0.22	29	13.4	4.84

83X, SPS SIK 36X, SPS SIK 47, SPS SIK 91, SPS SIK 1X and SPS SIK 3. The lowest first capsule heights obtained on SIK 031, SPS SIK 101/001, SPS SIK 51x and SPS SIK 93/2/003 were much higher than the recommended maximum value of 30 cm. The capsules were very long (with a mean of 2.69 cm). The mean capsule width was 0.77 cm. The longest capsules were observed on SPS SIK 122, SPS SIK 1 and SPS SIK 3 while the widest capsules were obtained from SPS SIK 93/2/002 and SPS SIK 93/2/003. The two traits were weakly ($P \leq 0.05$) interrelated and only capsule length had a significant ($P \leq 0.05$) positive correlation to seed yield ($r = 0.36$). As a matter of fact capsule width had no strong correlation to any of the traits studied. The most prolific cultivars in terms of capsule production were SPS SIK 93/001, SPS SIK 122, SPS SIK 1, SPS SIK 93/007, SPS SIK 51, SPS SIK 36, SPS SIK Z1 and SPS SIK 47. These cultivars had at least 80 capsules per plant. Some of these high capsule producing cultivars were also among the cultivars with high seed yield per plant, namely SPS SIK 122, SPS SIK 51, SPS SIK 47 and SPS SIK 93/001. Other cultivars with high seed production were SPS SIK 19 and SPS SIK 73 (Table 12).

During the short rains of October 1995 to February 1996 the cultivars had poorer performance than during the long rains of April to August 1995. The cultivars were averagely shorter, and had lower first capsule heights and shorter stretches on main stem from first capsule to stem tip. The respective means for these traits were 69.7 cm, 35.1 cm and

34.2 cm (Table 13). Plant height had significant ($P \leq 0.05$) relationships to the other two traits ($r = 0.71$ and 0.60 respectively). Plant height also had significant ($P \leq 0.05$) positive relationships to capsule length, capsules per plant and yield per plant ($r =$ 0.39, 0.74 and 0.49 respectively). The tallest cultivars were SPS SIK 10, SPS SIK Z1, SPS SIK 23x, SPS SIK 51x, SPS SIK 93/001 and SPS SIK 93/2/004. The cultivars which had the lowest capsule placements were SPS SIK 13, SPS SIK 101/001, SPS SIK 112 and SPS SIK 122. The mean capsule size measurements were 2.35 cm and 0.81 cm for capsule length and capsule width respectively. The longest capsules were obtained from SPS SIK 1x, SPS SIK 3, SPS SIK 51x and SPS SIK 93/2/003. The widest capsules were born on SPS SIK 93/002, SPS SIK 93/2/003 and SPS SIK 93/009. These capsule size measurements had a significant ($P \leq 0.05$) negative correlation ($r = 0.33$). Of the two traits only capsule length had significantly positive correlation ($r = 0.57$) to seed yield per plant. Seed yield was also significantly correlated to capsule number. Hence some of the cultivars with high capsule number like SPS SIK 93/2/004, SPS SIK 93/009, SPS SIK 93/001, SPS SIK 51x, SPS SIK 1x and SPS SIK 10 had fairly high yields (Table 13). The mean number of capsules per plant and seed yield per plant were 28 and 1.11 respectively.

Like for the case of April to August 1995 season the cultivars performed quite well in the long rains of April to August 1996 season. The plants were generally taller with more capsules that were larger, leading to higher seed yields as

Table 13: Mean performances of the cultivars in Experiment II at Siaya FTC in October 1995 to February 1996.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Length on main stem from first capsule to tip (cm)	Yield per plant (g)
SIK 031	71.5	38.5	2.40	0.80	26	33.1	0.82
SIK 083X	64.8	37.5	2.12	0.80	21	27.3	0.75
SPS SIK Z1	71.9	35.1	2.37	0.80	32	36.9	1.51
SPS SIK 013	63.1	28.7	2.22	0.72	23	34.6	1.11
SPS SIK 1	73.1	36.9	2.32	0.80	30	36.2	1.31
SPS SIK 10	80.8	37.9	2.40	0.80	33	36.4	1.84
SPS SIK 101/001	55.9	26.1	2.35	0.80	15	29.8	0.36
SPS SIK 112	62.8	28.1	2.31	0.80	27	34.8	1.32
SPS SIK 122	62.7	26.6	2.40	0.80	28	36.1	0.84
SPS SIK 1X	78.9	41.5	2.67	0.80	33	37.5	1.45
SPS SIK 23	72.5	32.1	2.36	0.80	29	40.4	1.56
SPS SIK 23X	74.4	34.8	2.30	0.80	33	39.6	1.12
SPS SIK 3	67.1	31.7	2.57	0.70	26	33.6	0.98
SPS SIK 36	67.6	35.0	2.31	0.80	29	32.6	1.26
SPS SIK 36X	70.2	32.5	2.30	0.80	29	32.7	0.86
SPS SIK 45	59.0	30.1	2.17	0.80	18	28.9	0.62
SPS SIK 47	69.3	33.8	2.40	0.80	24	34.9	1.05
SPS SIK 51	70.1	34.6	2.25	0.80	25	35.5	0.69
SPS SIK 51X	74.6	34.6	2.50	0.80	33	40.1	1.87
SPS SIK 73	61.5	31.0	2.17	0.80	28	30.6	1.16
SPS SIK 91	73.1	43.0	2.35	0.80	24	30.1	0.58
SPS SIK 93/001	73.9	35.8	2.52	0.80	31	38.1	1.42
SPS SIK 93/007	73.1	48.0	2.30	0.80	28	25.1	1.25
SPS SIK 93/009	64.2	30.3	2.45	0.90	31	34.0	1.65
SPS SIK 93/2/002	73.3	36.2	2.05	1.00	20	37.1	0.86
SPS SIK 93/2/003	71.7	40.7	2.12	0.91	27	30.5	1.00
SPS SIK 93/2/004	79.9	42.6	2.73	0.80	46	37.8	1.92
SPS SIK 96	72.0	39.1	2.42	0.80	26	32.9	0.00
MEAN	69.7	35.1	2.35	0.81	28	34.2	1.11
$LSD_{0.05}$	17.8	10.2	0.25	0.01	15	9.9	0.95

compared to their performances in the short rains of October 1994 to February 1995 and October 1995 to February 1996. The mean plant height, mean height to first capsule and mean length on main stem from the first capsule to stem tip were 134.5 cm, 54.9 cm and 79.0 cm respectively (Table 14). Unlike in the previous seasons plant height had no strong relationship to first capsule height though it had significant ($P \leq 0.05$) correlations to length on main stem first capsule to stem tip ($r - 0.82$), capsule length ($r = 0.38$), capsule number ($r = 0.69$) and seed yield ($r = 0.33$). Apart from the significant ($P \leq 0.05$) negative correlation to length on main stem from first capsule to stem tip ($r = -0.47$) first capsule height had no significant correlation to any other trait. The stretch on main stem from first capsule to stem tip was significantly correlated ($r = 0.72$) to number of capsules per plant. The tallest cultivars during the April to August 1996 season were SIK 083x, SPS SIK Z1, SPS SIK 23x, SPS SIK 36, SPS SIK 51, SPS SIK 73 and SPS SIK 91, while the cultivars with the lowest first capsule placements were SPS SIK Z1, SPS SIK 101/001, SPS SIK 73, and SPS SIK 93/001. Since length on main stem from first capsule to stem tip was positively related to capsule number the cultivars with high values for the former trait also had high values for the latter, namely SPS SIK 083x, SPS SIK Z1, SPS SIK 23x, SPS SIK 51, SPS SIK 51x, SPS SIK 91, SPS SIK 73, and SPS SIK 93/2/004. The other cultivars with high capsule number were SPS SIK 10, SPS SIK 36, SPS SIK 36x, SPS SIK 45 and SPS SIK 93/009. The average capsule number per plant was 94 while the mean values for capsule length and

Table 14: Mean performances of the cultivars in Experiment II at Siaya FTC in April to August 1996.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Length on main stem from first capsule to tip (cm)	Yield per plant (g)
SIK 031	126.3	55.4	2.55	0.88	70	73.4	4.9
SIK 083X	156.0	50.0	2.85	0.80	104	105.5	6.3
SPS SIK Z1	141.0	43.5	2.85	0.80	119	96.0	7.7
SPS SIK 013	137.9	58.7	2.52	0.71	91	79.8	4.6
SPS SIK 1	139.8	55.6	3.33	0.77	99	85.3	8.6
SPS SIK 10	134.0	58.7	2.80	0.83	102	75.5	8.8
SPS SIK 101/001	114.2	41.3	2.68	0.80	89	72.9	3.5
SPS SIK 112	132.7	58.6	2.81	0.80	85	74.1	6.1
SPS SIK 122	132.3	53.5	2.90	0.81	97	78.9	6.4
SPS SIK 1X	132.3	57.3	3.23	0.78	75	72.0	8.6
SPS SIK 23	126.3	55.7	2.78	0.72	85	70.3	7.1
SPS SIK 23X	140.8	55.2	2.63	0.87	102	85.7	7.5
SPS SIK 3	133.5	59.8	3.17	0.80	81	74.6	6.1
SPS SIK 36	143.3	65.3	2.87	0.75	93	78.1	8.9
SPS SIK 36X	134.1	58.1	2.81	0.80	115	75.5	8.0
SPS SIK 45	134.0	51.3	2.73	0.68	104	82.2	7.0
SPS SIK 47	139.4	67.3	2.62	0.80	87	72.7	5.3
SPS SIK 51	140.5	50.6	2.91	0.80	104	89.8	8.9
SPS SIK 51X	139.0	54.0	2.86	0.74	120	85.2	11.9
SPS SIK 73	140.1	44.3	2.67	0.80	106	85.8	8.1
SPS SIK 91	149.7	53.4	2.81	0.80	105	89.6	5.4
SPS SIK 93/001	114.3	46.0	2.68	0.80	66	65.6	4.2
SPS SIK 93/007	132.6	68.9	2.77	0.80	76	64.7	5.5
SPS SIK 93/009	128.2	63.6	2.82	0.92	104	64.6	7.4
SPS SIK 93/2/002	123.8	52.4	2.46	0.86	62	76.7	3.5
SPS SIK 93/2/003	128.4	59.3	2.50	0.94	80	69.3	5.2
SPS SIK 93/2/004	137.5	49.0	2.97	0.90	115	88.5	7.1
SPS SIK 96	132.1	52.2	2.80	0.80	99	79.9	6.2
MEAN	134.5	54.9	2.80	0.80	94	79.0	6.7
$LSD_{0.05}$	26.6	12.0	0.33	0.09	37	26.5	2.8

capsule width were 2.80 cm and 0.80 cm respectively (Table 14). While capsule width had no significant correlation to any of the traits capsule length had significant ($P \leq 0.05$) correlations to plant height ($r = 0.38$), length on main stem from first capsule to stem tip ($r = 0.33$) and seed yield per plant ($r = 0.46$). The longest capsules were observed on SPS SIK 1, SPS SIK 1x and SPS SIK 3 while the widest capsules were on SPS SIK 23x, SPS SIK 93/009, SPS SIK 93/2/003 and SPS SIK 93/2/004. The highest yielding cultivars were SPS SIK 51x, SPS SIK 1, SPS SIK 10, SPS SIK 1x, SPS SIK 36x, SPS SIK 36, SPS SIK 51, and SPS SIK 73. The mean seed yield per plant was 6.7g (Table 14).

Based on four seasons the cultivar selected from Experiment II for preliminary yield trials are enlisted in Table 15. They were selected based on consistent superiority in capsule production over the four seasons. The cultivars enlisted were among the best in terms of capsule production for at least two season. Of these cultivars SPS SIK 93/009, SPS SIK 36, SPS SIK 23x, SPS SIK 93/001, SPS SIK 122, SPS SIK 51, SPS SIK 10, SPS SIK 73, SPS SIK 51, SPS SIK 36x, SPS SIK 93/004 and SPS SIK 57x were among the best in terms of seed yield per plant in at least two seasons. Among the cultivars enlisted in Table 16 SPS SIK 45, SPS SIK Z1, SPS SIK 93/2/004, SPS SIK 112, SPS SIK 122 and SPS SIK 47 had also been previously reported (Ayiecho and Nyabundi, 1995) as promising.

Table 15: Cultivars selected for preliminary yield trials based on Experiment II at Siaya.

SPS SIK 45	SPS SIK 1
SPS SIK Z1	SPS SIK 36
SPS SIK 93/009	SPS SIK 73
SPS SIK 93/001	SPS SIK 51X
SPS SIK 93/2/004	SPS SIK 23X
SPS SIK 10	SPS SIK 1X
SPS SIK 36X	SPS SIK 96
SPS SIK 112	SPS SIK 13
SPS SIK 122	SPS SIK 47
SPS SIK 51	

Table 16: Analysis of variance mean squares for preliminary yield trials (Experiment I) conducted at Mtwapa in October 1994 to February 1995

Source	df	Plant height (cm)	First capsule height (cm)	Yield per ha (Kg)
Varieties	15	782.93**	688.36**	108080.38**
Error	31	169.83	70.30	19333.50

Based on the results of experiments I and II at Siaya it is evident that low first capsule height does not necessarily lead to high yields in the cultivars tested here. This parameter has been strongly recommended as a favourable selection criterion (Ashri, 1988 and 1994). However, as already indicated above this may be a favourable selection criterion in the unbranched cultivars. The cultivars tested here were mostly branched and the number of capsule bearing branches was observed to be having strong positive correlation to high first capsule height and the number of capsules per plant. Hence in the branched cultivars the number of capsule producing branches and the mean number of capsules per branch would probably be better selection criteria than low first capsule height. However excessive branching is undesirable and may lead to reduced yields. In previous studies we have observed significant positive correlation between these traits and capsule number per plant and seed yield per plant (Ayiecho and Nyabundi, 1995). From both experiments I and II it is also evident that sesame does better in the long rains than the short rains in Siaya. As already indicated the long rains seasons are always wetter than the short rains season in Siaya. This suggests that sesame will give a better crop if planted in the long rains because of more rainfall providing more moisture than in the short rains.

4.2.3.1.2B Experiments at Mtwapa

(i) Experiment I

The sixteen sesame cultivars subjected to preliminary yield trial at Mtwapa were significantly different for plant height, height to first capsule and seed yield per hectare (Table 16). The plants were generally short as the average plant height was 90.6 cm. The tallest cultivars were SIK 016, SPS SIK 113 and SPS SIK 6 (Table 17). Plant height was positively correlated to most of the traits studied (Table 18). Therefore the tall cultivars had high first capsule heights. Such cultivars included the above mentioned and SIK 052, SPS SIK 118, SPS SIK 45 and SPS SIK 78. The cultivars with the lowest first capsule height were SIK 031, SIK 056, SIK 065 and SIK 084 (Table 17). Long stretches on the main stem from the first capsule to stem tip were recorded on SIK 052, SIK 065, SPS 113, SPS SIK 50/1 and SPS SIK 6. The average value for this trait was 47.7 cm. Apart from height to first capsule and capsules per plant this trait was positively related to the rest of the traits (Table 18). Though the analysis of variance suggested no significant differences among the cultivars for the number of capsules on the main stem and the number of capsules per plant Duncan's multiple range and least significant difference tests revealed significant differences among some varieties. For examples SIK 056 and SIK 083 had significantly lower number of capsules on

Table 17: Mean performances of the cultivars in preliminary yield trials (Experiment I) at Mtwapa in October 1994 to February 1995.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsules on main stem (cm)	Capsules per plant	Length on main stem from first capsule to tip (cm)	Yield per ha. (Kg)
SIK 16	112.8	73.3	14	59	39.5	752
SIK 031	72.0	26.5	13	35	45.5	374
SIK 037	92.8	45.5	12	51	47.3	558
SIK 52	99.5	45.5	16	51	54.0	761
SIK 053	83.8	37.8	15	45	46.0	442
SPS SIK 56	59.0	19.8	10	34	39.3	325
SIK 065	78.8	28.5	14	36	50.3	385
SIK 083	91.5	44.0	10	31	47.5	247
SIK 084	74.5	27.8	18	40	46.8	222
SIK 096	87.0	41.5	12	35	45.5	353
SPS SIK 113	104.8	51.0	15	40	53.8	553
SPS SIK 118	96.3	52.5	13	42	43.8	420
SPS SIK 45	99.5	51.3	13	33	48.3	428
SPS SIK 50/1	98.3	39.8	28	39	58.5	461
SPS SIK 6	102.3	50.0	14	50	52.3	713
SPS SIK 78	97.8	52.3	12	46	45.5	470
MEAN	90.6	42.9	14	42	47.7	466
$LSD_{0.05}$	18.6	11.9	3	17	11.6	198

Table 18: Phenotypic correlations among the traits studied in preliminary yield trials (Experiment I) at Mtwapa in October 1994 to February 1995.

	First capsule height	Stem length from first capsule to tip	Capsules on main stem	Capsules per plant	Yield per plant
Plant height	0.87^{**}	0.58^{**}	0.27	0.60^{**}	0.64^{**}
First capsule height		0.11	0.10	0.58^{**}	0.60^{**}
Stem length from first capsule to tip			0.38^{**}	0.27	0.31^{*}
Capsules on main stem				0.46^{**}	0.02
Capsules per plant					0.56^{**}

the main stem than some cultivars, particularly SIK 052, SIK 084, SPS SIK 113 and SPS SIK 50/1. In case of the number of capsules per plant SIK 016 and SPS SIK 6 had more capsules than any cultivar with less 43 than and 33 capsules respectively. Other cultivars with high capsule number per plant were SIK 037, SIK 052, SIK 053 and SPS SIK 78.

The average seed yield per hectare was 466 kg/ha only. This was much lower than what we had reported previously for the same cultivars (Ayiecho and Nyabundi, 1995). The highest yielding cultivars were SIK 016, SIK 037, SIK 052, SPS SIK 113 and SPS SIK 6. In a previous report we identified SIK 016, SIK 037 and SPS SIK 113 as the highest yielders. Taking into account the performances of these cultivars in the present study and the study previously reported (Ayiecho and Nyabundi, 1995) the cultivars that may be recommended for replicated yield trials are SIK 052, SIK 016, SIK 053, SIK 037, SPS SIK 6, SPS SIK 113, SPS SIK 78, SPS SIK 50/1 and SPS SIK 118. These cultivars had seed yield of at least 400 kg/ha cultivars in the present study (Table 17) and a previous study (Ayiecho and Nyabundi, 1995).

(ii) Experiment II

The mean values for plant height, height to first capsule and length on main stem from first capsule to stem tip were 103.6 cm, 53.4 cm and 50.2 cm respectively (Table 19). Thus most of the cultivars were generally tall and at least 1m

Table 19: Mean performances of cultivars in Experiment II at Mtwapa during October 1994 to February 1995.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsules on main stem	Capsules per plant	Yield per plant (g)	Length on main stem from first capsule to tip (cm)
SPS SIK Z3	108.5	55.0	15	43	5.0	53.5
SIK 002	86.0	48.0	12	39	4.5	38.0
SIK 006	114.0	67.0	15	46	6.5	47.0
SIK 010	102.5	52.5	16	46	6.0	50.0
SIK 012	120.0	61.0	14	43	6.0	59.0
SIK 014	117.0	69.0	11	58	5.5	48.0
SIK 015	97.0	49.0	12	53	4.0	48.0
SIK 018	122.5	83.0	11	42	4.5	38.5
SIK 019	93.5	44.5	13	43	4.0	49.0
SIK 030	119.0	59.5	16	54	6.5	59.5
SPS SIK 31X	109.5	58.0	13	38	4.5	51.5
SIK 045	68.5	31.5	12	29	3.0	37.0
SIK 049	120.0	66.0	13	40	5.5	54.0
SIK 051	96.5	52.0	12	27	3.5	44.5
SIK 054	87.0	34.0	20	50	7.5	53.0
SIK 065	107.0	41.5	16	44	7.0	65.5
SIK 073	86.5	45.0	12	40	2.0	41.5
SIK 102X	108.5	52.0	15	31	4.5	56.5
SIK 103	96.5	46.0	14	35	3.5	50.5
SPS SIK 45	111.0	58.5	16	47	6.0	52.5
SPS SIK 10	109.5	54.5	15	37	4.0	55.0
SPS SIK 4X	119.0	56.5	17	50	5.5	62.5
SPS SIK 85	100.5	48.5	17	42	6.0	52.0
SPS SIK 96	85.5	48.5	11	28	2.0	38.0
MEAN	103.6	53.4	14	42	4.9	50.2
$LSD_{0.05}$	39.8	27.8	7	23	3.7	21.8

tall. The tallest cultivars were the locally acquired SIK 012 and SIK 018, and SIK 030 and SIK 049. Since plant height had significant ($P \leq 0.05$) correlation to most of the traits the tall cultivars had high first capsule height ($r = 0.84$) and long stretches on main stem from first capsule to stem tip ($r = 0.66$). Hence, the averagely tall cultivars like SIK 012, SIK 117, SIK 018, SIK 030, SIK 049, SIK 006 and SPS SIK 4x had high first capsule heights and/or long stretch on main stem first capsule to stem tip.

The number of capsules on the main stem were significantly ($P \leq 0.05$) related to the number of capsules per plant. Therefore most of the cultivars with averagely high capsule number on the main stem also had high capsule number per plant namely, SIK 010, SIK 030, SIK 054, SPS SIK 45 and SPS SIK 4x. Other cultivars with high capsule number were SIK 014 and SIK 015. As already observed in other experiments capsule number was significantly ($P \leq 0.05$) related to seed yield per plant ($r = 0.56$). High seed yields were observed for SIK 054, SIK 065, SIK 030 and SIK 006.

Based on capsule production it is recommended there that SIK 006, SIK 010, SIK 014, SIK 015, SIK 030, SIK 054, SPS SIK 45 and SPS SIK 4x be subjected to preliminary yield trials at Mtwapa.

4.2.3.1.2C Experiment at Kibwezi

The accessions studied in Kibwezi during April to August 1994 were highly variable for all the traits studied. Most of the accessions had heights of less than 100 cm except for SPS SIK 72, SIK 031, MMY0031, SIK 102x, UCR82-2x, SIK 019, SIK 104, SPS SIK 93/006, CN-2 and SPS SIK Z3. The shortest cultivars were SIK 001, SIK 004, SPS SIK 50001 and SIK 129 (Table 20). As already observed in studies at Siaya and Mtwapa plant height was significantly related to first capsule height ($r = 0.72$), length on main stem from first capsule to stem tip ($r = 0.70$), number of capsules on main stem ($r = -0.62$) and number of capsules per plant ($r = 0.40$). Therefore most of the tall cultivars had high first capsule placements and/or long stretches on main stem from first capsule to the stem tip. These included SPS SIK 72, SPS SIK 93/007, SIK 031, SIK 102x, UCR 82-2x, SIK 019, MMY 0031, SPS SIK 4, SPS SIK 93/006, CN-2 and SPS SIK Z3 (Table 20). The lowest first capsule heights were observed for SPS SIK 111, NAL 79.111.9, SIK 129, H45I, SIK 126, MI2, SPS SIK 50001 and SIK 001. First capsule height was not correlated to any of the traits except plant height. Mean capsule length and capsule width were 2.89 cm and 0.83 cm respectively. The cultivars which had the longest capsules were SIK 099, SPS SIK 72, SPS SIK 93/001, SPS SIK 111, NAL 79.111.9, SIK 031, SPS SIK 4, SPS SIK 121, SIK 118,SPS SIK 4, SPS SIK 113, SPS SIK 93/003, SPS SIK 50001 and SPS SIK 93/011. On the other hand the widest capsules were observed on SPS SIK 93/002, SPS SIK 72, SPS SIK 111, NAL 79.111.9, SPS SIK 4, SPS

Table 20: Mean performances of the cultivars at Kibwezi during April to August 1994

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules per plant	Capsules on main stem	Length on main stem from first capsule to tip (cm)
SIK 099	89.6	39.9	3.01	0.83	41	16	49.7
SPS SIK 93/002	92.2	47.8	2.67	0.87	39	14	44.4
SPS SIK 39	94.6	49.4	2.41	0.84	56	18	45.2
SPS SIK 72	103.9	51.4	3.09	0.91	39	16	52.5
SIK 127	93.9	46.5	2.68	0.78	41	17	47.5
SPS SIK 93/001	90.2	47.4	3.07	0.76	40	18	42.9
SPS SIK 111	86.6	36.1	3.01	0.87	52	16	50.5
SPS SIK 5002	92.0	39.1	2.91	0.86	42	17	52.9
NAL.79.111.9	82.9	37.4	3.10	0.87	41	16	45.5
SPS SIK 93/007	99.3	51.1	2.97	0.84	44	17	49.2
SIK 031	106.4	46.4	3.07	0.81	53	23	60.0
SIK 102X	103.0	39.8	2.99	0.85	49	22	63.2
UCR 82-2X	103.7	45.7	2.85	0.82	67	21	58.0
SIK 129	64.4	25.3	3.19	0.84	23	13	39.1
SPS SIK 121	88.7	45.8	3.18	0.80	50	18	43.0
SPS SIK 88X	94.8	44.9	2.95	0.84	40	16	49.9
SPS SIK 13	97.1	47.2	2.67	0.80	46	17	49.9
SIK 019	102.5	43.1	2.76	0.77	44	20	59.4
SPS SIK 93/008	89.4	43.1	2.80	0.82	50	14	46.3
MMY 0031	101.4	43.7	2.84	0.82	67	23	57.7
SIK 118	88.0	41.4	3.02	0.85	47	20	46.6
SPS SIK 93/010	94.2	47.3	2.87	0.77	43	17	46.9
SPS SIK 4	99.6	39.6	3.04	0.87	54	21	60.0
SPS SIK 50	82.7	37.7	2.71	0.80	34	16	45.0
H 45 I	58.6	25.8	2.68	0.78	27	9	32.8
SPS SIK 113	84.3	43.6	3.10	0.90	37	13	40.7
SIK 126	86.6	30.0	2.78	0.84	46	22	56.6
SPS SIK 93/003	88.8	38.5	3.16	0.89	33	14	50.3
SPS SIK 93/006	109.6	53.9	2.65	0.83	41	17	55.6
SPS SIK 4X	93.6	41.7	2.78	0.81	44	17	52.0
MI 2	81.0	32.3	2.91	0.81	38	14	48.7
B5	80.5	37.7	2.91	0.87	40	15	42.8
CN-2	107.9	52.7	2.90	0.81	33	18	55.3
SPS SIK 50001	73.0	29.4	3.04	0.82	38	16	43.7
SPS SIK 78	87.4	40.2	2.81	0.83	41	15	47.2
SPS SIK 93/011	82.9	37.7	3.10	0.85	40	16	45.2
SIK 001	78.5	35.8	2.84	0.81	40	14	42.8

SIK 107	95.3	39.8	2.76	0.83	44	18	55.5
SIK 120	88.6	43.7	2.97	0.84	48	15	44.9
SIK 004	78.0	41.6	2.72	0.73	34	13	36.5
SPS SIK 93/004	85.2	43.2	2.99	0.88	31	14	42.0
SIK 098	96.9	46.6	2.75	0.86	47	17	40.4
SPS SIK Z3	105.7	57.7	2.86	0.82	46	15	48.0
MEAN	90.8	42.1	2.89	0.83	43	17	48.5
$LSD_{0.05}$	15.9	11.2	0.30	0.14	19	7	14.8

SIK 113, SPS SIK 93/003 and B5. Capsule length and capsule width had a significant ($P \leq 0.05$) relationship ($r = 0.49$). The two traits had no significant relationship to any other trait. Capsules on the main stem and number of capsules per plant were strongly (P--0.05) correlated ($r = 0.65$). The mean capsule number on the main stem and capsule number per plant were 17 and 43 respectively. The accessions with the highest number of capsules per plant were SPS SIK 39, SPS SIK 111, SIK 031, UCR-82-2x, SPS SIK 121, SPS SIK 93/008, MMY 0031 and SPS SIK 4. Based on capsule production and freedom from diseases (especially *Cercospora* and *Alternaria*) and resistance to lodging, thirty accessions were selected for further tests at Kibwezi.

The performances of thirty accessions grown at Kibwezi in June to October 1995 season are presented in Table 21. The mean plant height was 92.3 cm with no significant variation among the cultivars. Similarly, with very few exceptions there were no significant differences among the accessions for capsule length, capsule width the number of capsules on the main stem and the number of capsules per plant. The mean values for these parameters were 3.09 cm, 0.94 cm, 23 and 52 respectively. Among the traits studied only the number of capsules on the main stem was significantly ($P \leq 0.05$) related to yield per plant ($r = 0.36$). The accessions with the highest seed yields were SIK 131, SPS SIK 6, SIK 031 and B5. Based on yield per plant, number of capsules on the main stem, freedom from disease attack, particularly *Cercospora* and *Alternaria*

Table 21: Mean performances of the cultivars at Kibwezi during June to October 1995.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules on main stem	Capsules per plant	Yield per plant (g)
SPS SIK 50	84.3	34.2	3.03	0.88	24	49	3.20
SPS SIK 121	85.5	35.9	3.11	0.88	23	43	3.45
SIK 099	94.1	37.6	3.06	0.89	26	59	5.75
SPS SIK 72	97.7	36.6	3.15	0.94	22	48	5.04
SPS SIK 113	83.9	38.5	3.11	0.92	20	50	3.90
SIK 107	89.4	31.1	3.00	0.85	22	52	6.23
SPS SIK 4X	88.0	38.6	3.00	0.92	23	58	5.05
SPS SIK 39	88.3	39.3	3.06	0.91	21	48	5.42
SIK 131	81.6	33.2	3.03	0.98	25	47	10.55
SPS SIK 004	91.8	42.7	3.01	0.92	23	64	4.49
SIK 098	90.0	35.8	3.26	0.96	22	63	7.83
SIK 019	87.7	36.2	3.06	0.97	22	50	4.62
SIK 126	93.0	37.1	3.07	0.96	22	52	4.95
SPS SIK 93/011	97.0	39.0	3.13	0.98	24	53	6.17
SPS SIK 93/009	88.9	39.7	3.05	0.96	20	54	6.40
SPS SIK 93/008	89.6	35.1	3.11	0.90	23	51	4.58
SPS SIK 6	102.7	40.7	2.96	0.92	27	52	9.25
SIK 031	92.1	35.0	3.13	0.90	23	52	8.23
SPS SIK 111	86.6	35.1	3.01	0.92	21	48	3.52
NAL 79.111.9	92.9	34.2	3.02	0.98	27	62	5.27
SIK 004	91.9	43.3	3.07	0.95	20	46	4.03
B5	90.5	39.2	3.30	0.98	24	46	8.32
SIK 102X	91.0	39.0	3.09	0.96	19	45	5.18
SPS SIK 93/001	97.1	51.0	3.17	0.96	24	60	4.61
SIK 001	92.2	40.1	3.00	0.92	20	57	5.22
SIK 127	95.1	39.7	3.11	0.93	24	54	5.23
SPS SIK 93/004	106.8	37.7	3.10	0.98	25	53	5.79
CN-2	103.9	40.6	3.10	0.96	24	53	5.82
SPS SIK 5002	98.8	37.3	3.15	0.99	25	46	6.39
SPS SIK 93/003	89.8	35.0	3.27	0.90	22	55	5.89
MEAN	92.3	37.9	3.09	0.94	23	52	5.68
$LSD_{0.05}$		7.4	0.24	0.10	7	19	3.60

leaf spots and downy mildew nineteen accessions were selected for preliminary yield trials at Kibwezi.

As was observed in the June to October 1995 experiment there were very few significant differences among the cultivars in the traits studied in the preliminary trials except for capsule length and seed yield per hectare (Table 22). In general the plants were generally tall with high first capsule placement. The average values for these traits were 144.2 cm and 78.8 cm respectively (Table 23). The capsules were also generally long especially for B-5, SPS SIK 121 and SIK 099. Stem length from first capsule to stem tip, capsule width, capsules on the main stem and capsules per plant had significant correlation to seed yield (Table 24). Seed yields were high with the mean among all the cultivars being 870 kg/ha. The best yields were obtained from SPS SIK 93/001, SPS SIK 93/004, CN-2, SIK 107 and SPS SIK 93/009 which had yields exceeding 1000 kg/ha. Though these cultivars did quite well in the preliminary yield trials strong recommendations can only be made on which cultivars should be subjected to replicated yield trials after at least another two seasons of on-station preliminary yield tests. One of the reasons for this suggestion is that Kibwezi lies in a region with very uncertain rainfall. During the October 1995 to February 1996 season there was a lot of rainfall which probably led to the good performance of the crop. In other seasons the rainfall was quite low as was the case during April to August 1994 and June to October 1995 seasons. In these two seasons the sesame

Table 22: Analysis of variance mean squares for preliminary yield trials at Kibwezi in November 1995 to February 1996.

Source	df	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules on main stem	Capsules per plant	Yield/ha (Kg)
Varieties	18	95.6	131.4	0.020*	0.00	11.8	158.7	106700.42*
Error	36	98.3	79.2	0.009	0.00	13.3	263.2	54176.87

* - Significant at $p \leq 0.05$

Table 23: Mean performances of cultivars in preliminary yield trials at Kibwezi during November 1995 to February 1996.

VARIETY	Plant height (cm)	First capsule height (cm)	Capsule length (cm)	Capsule width (cm)	Capsules on main stem	Capsules per plant	Yield per ha. (Kg)
SPS SIK 93/001	145.7	86.9	2.84	0.97	26	71	1021
SPS SIK 39	136.8	73.3	2.98	1.00	29	79	687
SIK 019	142.6	79.4	2.80	1.00	28	73	880
SIK 102X	152.0	87.6	2.84	1.00	27	74	881
SIK 127	143.5	77.6	2.82	1.00	27	66	967
B5	153.5	82.7	3.06	1.00	31	79	668
SPS SIK 93/004	141.4	75.0	2.97	1.00	30	76	1021
CN-2	145.0	73.1	2.84	0.97	30	72	1067
SIK 099	144.7	80.2	2.98	0.99	31	73	826
SPS SIK 50	137.7	72.1	2.74	1.00	27	60	919
SIK 004	145.6	88.1	2.88	1.00	24	73	742
SPS SIK 93/011	155.2	91.9	2.92	1.00	27	79	687
SPS SIK 93/003	141.2	72.1	2.90	1.00	28	72	919
SPS SIK 121	139.6	73.2	3.03	0.98	29	82	872
SIK 001	170.1	80.1	2.84	1.00	26	81	779
SIK 107	143.0	80.6	2.86	0.98	29	79	1002
SPS SIK 72	141.6	73.3	2.95	0.99	29	70	705
SPS SIK 5002	139.9	67.7	2.92	1.00	28	70	761
SPS SIK 93/009	153.4	82.5	2.89	1.00	30	95	1234
MEAN	144.2	78.8	2.90	0.99	28	75	870
$LSD_{0.05}$		14.7	0.15	0.02	6	27	315

Table 24: Phenotypic correlations among the traits studied in preliminary yield trials at Kibwezi during November 1995 to March 1996.

	First capsule height	Stem length from first capsule to tip	Capsule length	Capsule width	Capsules on main stem	Capsules per plant	Yield per plant
Plant height	0.70**	0.46**	0.12	-0.20	0.50**	0.49**	0.17
First capsule height		-0.31*	-0.16	-0.12	-0.07	0.16	-0.12
Stem length from first capsule to tip			0.36*	-0.11	0.77**	0.43**	0.39*
Capsule length				0.03	0.40*	0.44**	0.09
Capsule width					-0.17	-0.22	-0.31*
Capsules on main stem						0.54**	0.32*
Capsules per plant							0.46**

cultivars did much poorer. The plants were shorter and were less productive.

4.2.3.1.3. References

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4.2.3.2 CULTURAL STUDIES ON *Alternaria sesami* (KAW.) MOH. AND BEH. AND EFFECT OF SESAME (*S. indicum* L.) SEED TRANSMISSION AND PLANT AGE ON *Alternaria* LEAF SPOT SEVERITY.

4.2.3.2.1 Introduction

Consumption of edible vegetable oils is Kenya has risen considerably over the past years and in 1991 it was estimated of about 5 kg per capita per year. In 1991, Kenya's national requirement for vegetable oil was estimated at about 270,000 metric tonnes, of which only 15,000 metric tonnes was produced locally. Kenya's dependence on imported vegetable oil can be reduced through increased cultivation of oil crops. Among the oil crops grown in Kenya, sesame has the best adoption to the marginal agroecological zones and is drought resistant.

Among the production problems that currently limit the production of sesame in Kenya are damages caused by various pests and diseases. Among these diseases, *Alternaria* leaf spot caused by *A. sesami* has been observed on sesame and was first reported in Kenya by Gatumbi (1986). A preliminary survey conducted on sesame plants growing at the seed multiplication nursery at Siaya FTC in January 1996 indicated that *Alternaria* leaf spot was one of the most severe diseases on the crop at the time. Although the fungus *A. sesami* is seedborne, there are no commercially certified seed available to the Kenyan farmers that have tolerable amounts of *A. sesami* (Gichuki and

Gethi, 1988). This study was designed to investigate the optimal conditions for growth and sporulation of *A. sesami* in sesame, quantify the levels of *A. sesami* in sesame seeds and to determine their importance in disease development under field conditions. The specific objectives of the study were:

1. To identify conditions influencing *in-vitro* growth and production of *A. sesami*.
2. To determine the most sensitive and accurate test for assessment of seedborne *A. sesami* inoculum in sesame seeds.
3. To quantity the levels of *A. sesami* inoculum in seeds of cultivars largely used by small-scale farmers in Kenya and determine the effect of seed transmission on disease development and severity.
4. To evaluate the susceptibility of sesame plants at different ages to *Alternaria sesami* and its effect on seed injection.

4.2.3.2.2 Materials and Methods

Sesame seed samples were collected from small scale farmers in three districts in Kenya namely Busia, Kakamega and Siaya in January, 1996. Sampled seeds were subjected to various laboratory studies and later field studies at Kibwezi.

A. sesami was isolated from sesame seeds to culture and identify *A. sesami*, investigate conditions affecting *in-vitro* growth and sporulation of the fungus. *A. sesami* was assessed in sesame seeds using the agar plate, blotter and roll paper towel tests. The three methods were then compared for their efficacy in assessing the fungus for infection in sesame seeds. *In-vitro* growth and sporulation was conducted to determine optimal conditions in incubation tests for assessment of sesame seeds for infection by *A. sesame.* Effect of media composition and quantity, incubation period and media pH, and temperature and light regimes were conducted in a split-plot experimental design. Radial growth and conidial concentration were used for subsequent data analysis.

Glasshouse conditions were carried out to test pathogenicity of *A. sesami* on *S. indicum* as well as to assess the virulence differences among *A. sesami* isolates from Busia, Kakamega and Siaya districts. The fungus used for the study was isolated from the infected sesame seeds and conidial concentration of virulence assessment standardised to 2×10^1, 2×10^2 and 2×10^3 conidial/ml. After 3-4 days of inoculation 10 leaves per plant were picked from the top, middle and bottom portions of the plant. The number of lesions were then counted and average values computed for data analysis.

Field studies were conducted to determine effect of seed transmission of *A. sesami* and plant age on *Alternaria* leaf spot severity. Seeds with inoculum levels of 2-8% were planted out at Kibwezi for two seasons. Five plants ages of cultivar SPS SIK 110 namely 4, 6, 8, 10 and 12 weeks were used to assess the susceptibility of sesame to *A. sesami*. *Alternaria* leaf spot was assessed in terms of severity. Severity was estimated by use of percent leaf area diseased and percent defoliation from May 1996 to October 1996, using a modification of the technique described by Berger (1975). Area under disease progress curves (AUDPCs) were computed from percent leaf areas infected and percent defoliation using the formula of Shaner and Finney (1977):

$$\mathbf{AUDPC = \Sigma\ [(Y_{i+1} + Y_i)/2](X_{i+1} - X_i)}$$

where $\mathbf{Y_i}$ = Disease severity per unit at the ith observation

$\mathbf{X_i}$ = Date of ith observation.

Gompertz and logistic models were fitted to % infected leaf areas and % defoliation. Apparent rates of disease increase were obtained by regressing transformed data against time. Averages of AUDPC, infection rates and defoliation rates were examined using analysis of variance. Significant differences were identified using Duncan's multiple range test.

4.2.3.2.3 Results and Discussion

Conditions influencing *in-vitro* growth and sporulation of *Alternaria sesami* were studied to determine the optimal conditions for assessment of fungal inoculum in sesame seed samples collected from farmers in Siaya, Kakamega and Busia districts, Kenya. *A. sesami* isolated from the above seeds produced the largest colonies with abundant sporulation on oat meal agar. Quantity of media that supported optimum growth and sporulation was 35-ml per 9-cm diameter petri-plate. Greater mycelial and conidial production occurred at pH 4.5. Prolonged incubation increased growth and sporulation of the fungus until the 8th day at pH levels below 8.0. Continuous darkness increased and depressed growth of *A. sesami* at temperature below 30°C and 35°C, respectively. Sporulation of the fungus was greater under continuous darkness than under continuous light and alternating light/dark cycles, at temperature of 25°C and below. At higher temperatures, illumination treatments did not produce significant effects on conidial production. Optimum temperature for culturing the fungus was 25°C.

The agar plate, blotter, and roll paper towel tests used to assess *A. sesami* in seed samples detected infection levels varying from 3.93% to 16.43%. Seeds collected from Siaya District had the highest mean infection level of 12.61% whereas Busia and Kakamega districts had mean infection levels of 8.42 and 5.46% respectively (Table 25). The agar plate method consistently detected the highest number of fungal propagules.

Pathogenicity and virulence of different isolates of *A. sesami* on cultivated sesame (*S. indicum*) were investigated under glasshouse conditions. Within 6-10 days following

Table 25: Percent infection levels of seedborne *A. sesami* in farmer's seeds as determined by the incubation tests.

Sampling Area	Percent infection[a]			
	Agar plate	Blotter	Roll paper	Mean[b]
Siaya District				
Alego	20.00	10.17	6.10	12.27c
Bondo	19.00	11.10	5.80	11.97ef
Boro	18.10	11.80	5.80	11.90f
Hawinga	19.00	12.00	5.00	12.00e
Rarieda	24.20	15.00	10.10	16.43a
Ugunja	21.10	10.80	5.10	12.33c
Ukwala	19.50	10.90	6.10	12.17d
Usingu	18.10	14.5	7.50	13.28b
Mean	19.74	12.07	6.44	12.61
S.E.	0.47	0.54	0.55	
LSD (5%)	1.08	1.25	1.25	
Busia District				
Alupe	11.00	8.25	7.75	9.00d
Amagoro	10.10	7.75	6.80	8.22f
Amukura	13.10	9.10	6.70	9.60a
Angoromo	13.10	8.50	6.20	9.27c
Bugengi	14.00	10.10	4.00	9.37b
Butula	11.10	9.50	4.80	8.47e
Mayenje	10.00	6.50	3.75	6.75g
Roadblock	11.10	5.25	3.50	6.62h
Mean	11.69	8.10	5.44	8.41
S.E.	0.49	0.53	0.54	
LSD (5%)	1.13	1.22	1.25	
Kakamega District				
Butere	10.07	6.25	4.00	6.77b
Khwisero	8.10	5.05	1.75	4.97c
Lurambi	10.00	8.02	4.05	7.36a
Majengo	11.00	6.00	3.08	6.69b
Mumias	7.50	3.40	0.90	3.93f
Municipality	9.47	4.35	1.02	4.95c
Navokholo	7.50	5.00	0.75	4.42e
Shinyalu	8.04	4.95	0.75	4.58d
Mean	8.96	5.38	2.04	5.46
S.E.	0.44	0.46	0.48	
LSD (5%)	1.01	1.06	1.11	
Overall mean[c]	13.32	8.52	4.64	
S.E.	0.46	0.51	0.52	

[a] Each value is an average of 3 replicates. [b] Average of means over the three incubation techniques values followed by the same letter do not differ significantly at P = 0.01 (Duncan's multiple range test).
[c] Average of means over the 24 sampling areas as determined by the incubation technique. LSD at P = 0.05 for comparison of percent infection is 0.04% across the incubation tests.

Table 26: Effect of leaf spot severity caused by seedborne *A. sesami* on seed yield components in sesame at Kibwezi[a].

Inoculum level (%)	Disease severity AUDPC - DL	Yield loss (%)	Yield[b] (Kg/ha)	1000-seed weight (g)	Seeds per capsule	Capsules per plant
0	0.14	0	312.50a	3.97	60.5	42.8
2	0.34	4	300.10ab	3.82	58.8	38.6
4	0.60	7	290.60abc	3.71	55.1	39.4
5	1.40	10	283.70abcd	2.70	51.1	40.3
7	1.77	18	255.10cde	2.20	50.7	37.8
8	2.28	25	234.90e	2.10	45.4	49.4
Mean			279.50	3.10	53.6	39.7
Correlation coeffient (r)[c]			-0.84*	-0.89**	-0.86*	-0.37
Correlation coeffient (r)[d]				0.84*	0.80*	0.58

[a] Seed yields were not significantly different in season one and season two. Yields and yield components, therefore, presented for combined season one and two data; AUDPC - DL used for correlation are averages of season I and II.[b] Averages of 3 replications; means followed by the same letter do not differ significantly at $p = 0.01$ (Duncan multiple range test). [c] Correlation coefficients of *Alternaria* leaf spot severity against yield and yield components.[d] Correlation coefficients of yield against yield parameters.

[e] Correlation coefficient marked by one or two asterisks are statistically significant at $p = 0.01$ or $p = 0.001$, respectively.

inoculation, the fungus produced characteristic symptoms on *S. indicum*. All the isolates were pathogenic to *S. indicum* and the Siaya isolate was the most virulent.

Alternaria leaf spot was monitored in field plots with six different natural inoculum levels of *A. sesami* in the sampled seeds and at five plant ages. Increase in percent leaf area diseased and percent defoliation fitted the Gompertz model more closely than the logistic model. Rates of disease increase in infected leaf areas and defoliation as well as areas under disease progress curves (AUDPCs) varied among levels of seedborne inocula and the plant ages studied. Plots with 8% and 0% seed inocula were consistently associated with the highest and lowest severity, respectively. Yield losses of upto 25% were observed at 8% level of seed inoculum (Table 25). Leaf spot severity was significantly negatively correlated to seed yield one thousand (1000) seed weights and seeds per capsules Seed yield was significantly positively correlated to 1000 seed weights and seeds per capsule (Table 26). A major effect of *Alternaria* leaf spot severity was on the 1000 seed weight. Sesame plants were most susceptible at average of 10 weeks of ages. Highest *A. sesami* seed infection occurred on inoculating plants at 10 weeks and plants incubated at 12 weeks had the least seed infection.

Growth and sporulation of *A. sesami* is important for assessment of the fungus in seed health testing. This study has shown that growth of the fungus is optimum when plates containing or 35-ml of oat meal agar at pH 4.5 are used. Thus these conditions can be used in the agar plate method for optimal results. For optimum sporulation, plated agar plates and blotters should be incubated at 25°C under continuous darkness for 6-8 days. The seed health tests also revealed that all the sesame seeds used for planting in Kenya are infected by *A. sesami*. However the low levels of seed infection in Kakamega samples indicate the possible production of pathogen free seed in the district. The agar plate method was most sensitive in assessment of the fungus in sesame seeds.

Effective control of *Alternaria* leaf spot can be achieved if spraying is done when plants are 10 weeks old. Infection of sesame seeds by *A. sesami* can be reduced through reducing the duration of the flowering period of sesame, i.e. planting early varieties. In addition use of seeds with less than 20% infection for planting could also achieve considerable control of the disease.

4.2.3.2.4. References

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5. RESEARCH CAPACITY BUILDING

5.1 Objective: Build capacity for sesame research within the country.

5.2 Achievement

During the year that just ended three M.Sc. students accomplished their studies under the project. These were Mr. Karl Nyabundi, Mr. Kyalo and Mr. Ojiambo. Their M.Sc. research topics were focused on the objectives of the project. The mentioned three graduate students were among the several students who did their M.Sc. training while affiliated to the project. Those who had previously accomplished their studies in the project were James Nyanapah, Danstan Odeny and F. Maimba.

As a part of the research capacity building a number of research assistants were attached to the project. These gained a lot of experience in sesame research. Similarly, the personnel of the institutions/centres where we have been conducting our research also gained direct or indirect experience in sesame research, especially the personnel at Siaya F.T.C.

6. RECOMMENDATIONS

1. Thirteen varieties be subjected to replicated yield tests in western Kenya before releasing the best to the farmers for commercial production. Such replication yield tests should be carried along with on-farm trials and sesame oil extraction at the farm level using appropriate simple technology like use of the ram press.

2. Another 19 cultivars be subjected to preliminary tests at Siaya for at least two seasons.

3. The sixteen cultivars subjected to preliminary yield tests at Mtwapa should be subjected to similar tests for another two seasons before the best can be recommended for replicated yield tests and on-farm trials. In the preliminary yield trials another eight cultivars from Experiment II should be included.

4. Preliminary yield trials involving 19 cultivars at Kibwezi should continued for another three seasons before the best of them could be recommended for replicated yield tests and on-farm trials.

5. Seed to be used by the farmers should be obtained from fields with low *Alternaria* leaf spot infection.

7. DISSEMINATION OF PROJECT RESULTS

As had been indicated in our first two reports of Sesame (K) Project II some results of the project were published East African Agriculture and Forestry Journal Sesame and Safflower Newsletter, students´ theses and workshops and seminars. Sesame Production Handbook for Kenya was also written by us for free distribution to the sesame farmers, sesame researchers and agricultural extension workers in sesame growing areas. The farmers who visited Siaya FTC during open days of the FTC also obtained information relating to improved sesame production technology developed by the project. The farmers have already taken some of the project´s promising varieties for cultivation.

8. PROJECT PERSONNEL

Name	Institution	Role
Prof. I.K. Rop	Egerton University	Principal Investigator
Dr. P.O. Ayiecho	University of Nairobi	Project Leader and Researcher (Breeder)
Dr. J.O. Nyabundi	University of Nairobi	Researcher (Agronomist)
Mr. D.A. Odeny	Egerton University	Research Assistant
Mr. I. Owando	Egerton University	Research Assistant